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SUFFIELD MEMORANDUM

NO. 1394

DRES CHEMICAL AGENT DETECTION SYSTEM II AND MINITUBE AIR SAMPLING SYSTEM DEPLOYMENT AND PERFORMANCE IN SUPPORT OF UNSCOM 29 CHEMICAL DESTRUCTION I, KHAMISIYAH, IRAQ

by

W.R. Sturgeon

August 1992

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ABSTRACT

Canada contributed a team of 6 personnel to the United Nations Special Commission 29 for the destruction of 122 millimeter chemical fill rockets at Khamisiyah, Iraq. This team was composed of 2 military officers and 2 civilian personnel from the Defence Research Establishment Suffield (DRES), Alberta, Canada, and augmented by 2 military personnel from Canadian Forces Europe, Lahr, Germany. The team was assigned the duties of detection, monitoring and meteorology, and deployed with them the DRES-designed Chemical Agent Detection System (CADS) II and the Minitube Air Sampling System (MASS). The CADS II and MASS were deployed downwind of the rocket destruction site for atmospheric monitoring and sample collection for retrospective analysis at DRES.

This paper details the deployment of the DRES team and equipment to Iraq during the period 12 February 1992 to 25 March 1992, the logistical and operational problems encountered, equipment performance and recommendations for improvements in a number of areas associated with the deployment.

RÉSUMÉ

Le Canada a affecté à la Commission spéciale n° 19 des Nations une équipe de six personnes chargées de la destruction, à Khamisiyah, en Irak, de roquettes de 122 millimètres à charge chimique. Deux officiers et deux civils du Centre de recherches pour la défense de Suffield (CRDS) situé en Alberta, au Canada, composaient cette équipe à laquelle sont venus s'ajouter deux membres des Forces canadiennes de la base de Lahr, en Allemagne. L'équipe, qui était responsable de la détection, du contrôle et de la météorologie, avait à sa disposition le système de détection d'agents chimiques (CADS II) et le système à minitube servant au prélèvement d'échantillons d'air (MASS), qui ont été conçus au CRDS. Le CADS II et le MASS ont été déployés sous le vent par rapport au site de destruction des roquettes, où ils ont permis de contrôler l'atmosphère et de prélever des échantillons d'air destinés à être analysés ultérieurement au CRDS.

Dans cette communication, on décrit en détail le déploiement de l'équipe du CRDS et de son matériel en Irak au cours de la période allant du 12 février 1992 au 25 mars 1992; on décrit aussi les problèmes logistiques et opérationnels auxquels l'équipe a été confrontée et la performance du matériel, et on formule des recommandations visant à améliorer un certain nombre de points liés au déploiement.

EXECUTIVE SUMMARY

Under Resolution 687, the United Nations is involved in overseeing the destruction of Iraqi chemical and biological weapons and production facilities. This is being completed through the creation of a series of United Nations Special Commissions. United Nations Special Commission 29 was established to oversee the destruction of a number of Iraqi chemical-fill 122 mm chemical rockets retrieved from the Khamisiyah Ammunition Storage Depot, about 350 kilometers south-east of Baghdad. These rockets were intact with burster charges, propellant and rocket motors. They were also in a deteriorating condition and were leaking nerve agent. As a result, they were considered too dangerous to move to the designated destruction site at Muthanna State Establishment, and would require to be destroyed in -situ.

Canada was requested to provide personnel and equipment to perform a site monitoring and detection capability during the destruction operations. To carry out these duties, Canada despatched a team composed of two military officers and two civilian technicians from the Defence Research Establishment Suffield (DRES) and two military members from Canadian Forces Europe. In addition, a Swiss officer was assigned to the team in Iraq. While on-site at Khamisiyah, the team performed the following duties:

a. meteorological assessments;

b. personnel and vehicle monitoring;

c. chemical rocket monitoring during handling and transport and ground contamination monitoring following explosive destruction of rockets;

d. downwind hazard detection and warning using the Chemical Agent Detection System (CADS) II;

e. air sampling using the Minitube Air Sampling System (MASS) for retrospective analysis at DRES;

f. water, soil and agent sampling using the DRES sampling kits for retrospective analysis at DRES; and

g. additional duties such as a recce of the Mohammadiyat Ammunition Depot 100 kilometers west of Baghdad.

The team was quartered in Baghdad which necessitated a 4 hour round-trip to Khamisiyah each day. At Khamisiyah, a Base Camp was established outside the Ammunition Depot, about 2 kilometers west of the rocket storage site. The rocket destruction site was located 15 kilometers east of the storage site at the edge of a dry salt marsh. This site contained a series of destruction pits dug into the earth, and two earthen berms constructed 500 and 1000 meters upwind to protect personnel and equipment during rocket detonation. The rockets were transported from the storage site to the destruction site in gravel trucks, and off-loaded into pits. Each pit contained up to 10 rockets which were destroyed using explosive charges to cut open the warhead, body and motor and to simultaneously ignite a diesel/gasoline (25:75) fuel mix. The resulting fireball was used to thermally destroy the agent fill. A maximum of 40 rockets were destroyed on any one day.

Eight CADS II sensor stations were set up downwind of the destruction pits: 5 at 200 meters and 2 at 1800 meter distances downwind, each covering a 400 meter front; one station was set upwind of the destruction pits. Three minitube air sampling stations were also deployed 200 meters downwind.

A total of 425 rockets and warheads with agent fill were destroyed in addition to 38 rocket motors. Six out of 16 detonations activated the CADS II sensors at the 200 meter position. Maximum readings obtained were 3 bars. Samples of agent, soil and water were gathered and turned over to the French for retrospective analysis. Samples collected from the MASS were returned to DRES for analysis and subsequently revealed the presence of nerve agents GB (sarin) and GF.

A number of recommendations were made following the mission. The more pertinent of these areas follows.

a. CADS II. The system performed very well. Only minor design changes were recommended to improve the man/machine interface;

b. MASS. This system performed reasonably well considering it is not ruggedized for military use. Problems were encountered as a result of sand in the electronics, loose circuit boards and a blown fuse for which no spare was available. It must be determined whether this system has any future use with the Canadian Forces before any attempt is made to ruggedize the system;

c. Protective Equipment.

1. Military clothing was not authorized for this mission. Proper non-restrictive, non-military environmental clothing should be provided.

2. A simple and effective method should be developed by the Canadian Forces for personal testing of the NBC mask seal in the field, and it is recommended that amyl acetate, or a suitable alternative such as methyl salicylate, in a miniature aerosol dispenser or pump be developed for personal issue.

3. A lighter-weight NBC overgarment is urgently required for work in hot climates.

4. Goggles are required for use in desert areas where blowing sand presents a hazard to the eyes. These should be available in the CF supply system for individual issue.

5. A disposable plastic sun-shade or tinted wrap-around goggles are required for use with the C4 mask when working in areas of dazzle from bright sunlight and reflection off sand or snow.

6. Investigation into the development of disposable plastic prescription lenses that may be fitted to the exterior eyepieces of the C4 mask should be undertaken.

d. Medical. Positive steps should be taken to enlighten Allied nations regarding accepted Canadian medical treatment procedures. Team members were not permitted to use HI-6 and diazepam injectors for treatment of nerve agent poisoning.

e. Other Factors.

1. Notification. Members were given very late notice of their participation in this mission. This created undue confusion and deployment tasking problems. Earlier notice of tasking is required in the future.

2. Fatigue. The team worked 28 days with only one day of rest which induced chronic fatigue and dissatisfaction. Programmed rest schedules were cancelled by the UN because of increased workload brought on by the discovery of extra buried rockets. Rest schedules should be adhered to, especially when working in a hazardous environment.

3. Sanitation. Sanitation was a serious problem. There was no toilet facility established at the destruction site and the area became littered with human (Iraqi) feces. Provision of a chemical toilet on-site is considered mandatory on future missions.

4. Sampling. Samples of agent, soil and water collected by the team could not be transported back to DRES for analysis because there are no provisions established for the transport of such materials. Standard Operating Procedures require development.

5. Civilians. Civilian personnel will undoubtedly be employed on hazardous missions of this nature in the future because their expertise cannot always be replaced by equivalent military expertise. When they are required to participate, details of their deployment should be documented in writing prior to departure to include such things as overtime benefits, life insurance liabilities, working conditions and child care expenses, and they should indicate a willingness to work under spartan conditions.

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ACKNOWLEDGEMENTS

The author would like to thank a number of people who proofread the draft paper and provided comments for corrections and improvements. First of all, to those DRES personnel who participated in this exciting adventure and whose comments are incorporated in this paper: Maj A.R. Carruthers, Mr D. Verpy and Mr G. Soucey. Secondly, to those who corrected grammar, spelling and technical errors: Mr B. Laidlaw, Dr G. Purdon, Dr P. Lockwood, Dr J. Armour, Mr J. Hancock, Dr C. Boulet, Dr C. Cherwonogrodzky and Dr J. McAndless.

INTRODUCTION

The Defence Research Establishment Suffield (DRES) was involved with the Persian Gulf War of 1991 (Operations Friction and Scimitar) specifically in the area of development and deployment of chemical and biological detection and warning systems to the Canadian Forces Middle East (CANFORME). In the aftermath of the war, DRES expertise was requested by the United Nations (UN) for the inspection of Iraq's chemical and biological warfare facilities under United Nations Special Commissions (UNSCOM) 2, 7 and 17. Most recently, DRES personnel were requested to participate in the first destruction of Iraqi chemical munitions under the auspices of UNSCOM 29 (Operation Forum).

For UNSCOM 29, DRES was requested to provide atmospheric monitoring and sampling equipment for both quantitative and qualitative assessment purposes in order to assess the effectiveness of the rocket destruction process and to evaluate any impact on the environment. For these purposes, the recently-developed Chemical Agent Detection System (CADS) II and the Minitube Air Sampling System (MASS) were deployed to the rocket destruction site at Khamisiyah during the period of 12 February to 23 March 1992. A description of these systems is attached as Annexes A and B respectively.

The deployment chronology is detailed at Annex C.

UNSCOM 29 COMPOSITION AND MANDATE

UNSCOM 29 Chemical Destruction I was established under UN Resolution 687 to destroy a number of Iraqi 122 mm chemical-fill rockets that had been retrieved from the Khamisiyah Ammunition Storage Site, a military compound about 350 kilometers south of Baghdad. A number of chemical-fill (GB/GF) rockets, many of them leaking, had been retrieved from this compound by the Iraqis and "stored" in tangled piles in a ground depression outside the Khamisiyah complex. Initial estimates indicated that about 300 to 350 chemical rockets, complete with warheads and rocket motors required disposal. The chemical agent fill, intact burster charges, propellant and motors were highly unstable as a result of damage and corrosion due to exposure to the elements and a highly acidic agent mixture (the nerve agent fill contained no stabilizers resulting in acidic decomposition products that corroded the container, seals and rocket body). As a result, it was considered by the UN that these rockets were too unstable to move to the designated chemical destruction site at Muthanna, and

therefore they would have to be destroyed in-situ. An Operational Plan was developed by the UN for this operation, and is attached as Annex D.

Destruction of the rockets and agent in-situ was to be governed by the following guidelines:

a. destruction operations would be carried out by Iraqi personnel under the direct supervision of UNSCOM staff; and

b. as Iraq had no safety and environmental standards governing such an operation, Western safety standards would be applied as much as possible and steps taken to minimize the impact on the environment resulting from the destruction process.

To accomplish this mission, the UNSCOM 29 team was composed of 26 people from a variety of countries and organized into 8 sub-teams (Annex E):

a. command and control staff - 4;
b. detection, monitoring and meteorology - 7;
c. decontamination - 4;
d. explosive ordnance disposal (EOD) - 2;
e. medical - 6;
f. communications - 1;
g. photography - 1; and
h. interpretation - 1.

DRES personnel comprised the nucleus of the Detection, Monitoring and Meteorology Sub-Team. This team was augmented by two military members from Canadian Forces Europe (CFE) and one military officer from Switzerland. Non-DRES personnel were familiar with chemical operations but were not familiar with the specialized DRES equipment. This sub-team performed the following functions at Khamisiyah:

a. produced a sub-team operational plan and provided safety template estimates, meteorological data and atmospheric stability assessments prior to rocket destruction. Equipment used for the meteorological function included a sling psychrometer (wet/dry bulb), anemometer, magnetic compass/ clinometer, infra-red pyrometer and Pasquill stability charts. This data was passed to the UNSCOM Team Leader for inclusion in the final report to be produced by the UN. A copy of the sub-team Operational Plan is attached as Annex F;

b. conducted personnel and vehicle monitoring for contamination at the rocket storage site and at the rocket destruction site. Equipment used to monitor personnel and vehicles for contamination included the UK hand-held chemical agent monitor (CAM), the French AP2C chemical agent monitor, and the Canadian C2 chemical detection kit and 3-way detection paper;

c. monitored chemical rockets during their handling and transport, and conducted ground contamination monitoring using the CAM to monitor the ground, shrapnel and the destruction pits following explosive destruction of rockets;

d. provided downwind hazard detection and warning using the CADS II;

e. collected air, water, soil and other samples as required using the MASS and DRES sampling kits for retrospective analysis at DRES; and

f. performed additional recces such as at Mohammadiyat Ammunition Depot.

SITE LAYOUT

The UNSCOM 29 headquarters and team personnel were lodged at the Ishtar Sheraton Hotel, Baghdad. This necessitated a daily 4 hour round-trip between Baghdad and Khamisiyah. There was no suitable commercial accommodation obtainable closer to Khamisiyah. This tiring and non-productive trip was made by bus from the hotel to Al Rashid Air Base Baghdad, then by Sikorsky UH-53 helicopter escorted by two Iraqi tactical helicopters to the Base Camp established outside the perimeter of the Khamisiyah Ammunition Storage Site. The Base Camp was located at latitude and longitude approximately 30° 45' 25.4" and 46° 25' 01.1" respectively. Equipment was airlifted by UH-53 directly to the Base Camp. DRES equipment was packed in three "Paul Bunyan" containers. In addition there were 6 crates containing 60 CAMs obtained from Canadian Forces Supply Depot Montreal, 11 spools of twisted pair wire totalling 20 kilometers and the palletized DRES diesel generator. All equipment was off-loaded and arranged at the Base Camp. Site security was provided by armed Iraqi guards on a 24/7 basis.

Base Camp was spartan, consisting of a mess tent, field latrine, decontamination tent, communications vehicle

and antenna (satellite communications) and a transport trailer for storage of equipment, water and rations. In addition, the Iraqis had a command trailer and several tents for guards and workers. Initially the transportation helicopter landed and departed from Base Camp each day, and all personnel had to travel to the other two sites by vehicle. After site security had been established at the destruction site, Base Camp was rarely used by sub-team personnel, and the helicopter arrived and departed directly from the rocket destruction site.

The rocket storage site was located 2 kilometers from Base Camp, and the destruction site 15 kilometers from the storage site. Travel between all three sites was by UN 4-wheel drive vehicle. Each sub-team was assigned one vehicle. A communication net was established by radio, and each sub-team was issued one or two hand-held Motorola walkie-talkies and assigned a call sign (the Detection team was Charlie Sierra, CS). Armed security was provided at the rocket storage site, but initially not at the destruction site. Security would not be established there until the operation had been running for 7 days. This was to create problems for the DRES team in setting up the CADS system prior to rocket destruction operations each morning and dismantling the system prior to helicopter departure each evening.

The rocket destruction site was located at the western edge of a dry salt marsh. The land was extremely flat and visibility unlimited (horizon to horizon). To the north and north east were several small settlements of marsh people and Bedouin, so the downwind vector was directed to the uninhabited area south east. Winds were prevalent from the north-west. A series of destruction pits were dug, each 50 meters apart. Upwind of the destruction pits, at 500 meter and 1000 meter points, earthen berms (about 20 meters long and 3 meters high) were constructed to protect personnel and equipment during rocket demolition. The 1000 meter berm was used only once and it was determined that the distance from the destruction pits was unnecessarily far. Subsequently all operations were based from the 500 meter berm.

After the 7th day of destruction operations, site security was established by the Iraqis. No proper field hygiene was established for UNSCOM personnel. The closest field latrine was located 17 kilometers away at Base Camp. In addition, there was no facility available for personal cleaning prior to eating (a simple wash rack, water and soap would have sufficed). This was compounded by the requirement

to work in an area littered with (Iraqi) human feces. The lack of basic field hygiene caused consternation among team members, and is considered a serious omission on the part of the UN. The author feels that the team members were at a health risk since pathogenic organisms such as Brucella are endemic in the Middle East and could be aerosolized from contaminated fecal droppings. This health risk was in addition to that posed by the rocket destruction process (explosives, nerve agent). Proper sanitation should be one criterion for future Canadian participation in UN activities of this nature. All personnel were issued with bottled water and US Army "Meals Ready-To-Eat" (MRE) while in the field. Garbage was burned daily in a pit near the 500 meter berm.

EQUIPMENT SET-UP

A. CADS II

The CADS II is a ruggedized design for military use commercially marketed by Scientific Instrumentation Limited (Saskatoon, Saskatchewan). The system deployed consisted of one Central Control Unit (CCU) and 8 Land Sensor Stations (LSS). Although solar panels were available, the system was set to run from battery power. Batteries were regularly rotated and recharged using the charger and diesel generator. It was believed that the solar panels, had they been used, would have been damaged by shrapnel as shrapnel was discharged for distances of at least 300 meters from the destruction pits. The CCU was positioned at the top of the 500 meter berm, power being supplied by the diesel generator and an extension cord. Communication between the CCU and the 8 LSS was through VHF radio frequency (RF) link (channel 1).

The LSS were erected in a line perpendicular to the anticipated downwind direction at 200 meters and 1800 meters from the downwind edge of the destruction pits. The 200 meter line consisted of 5 LSS spread over a 400 meter front bearing 334°. The west end LSS was sited at latitude and longitude 30° 43' 30.5" and 46° 35' 30.4" respectively. The east end LSS was sited at latitude and longitude 30° 43' 40.2" and 46° 35' 39.7" respectively. The 1800 meter line consisted of 2 LSS over a 400 meter front bearing 34°. The latitude and longitude of the LSS were not recorded. LSS number 8 was sited 760 meters upwind between the 500 meter berm and the villages to the north.

The CADS II was erected and dismantled each day for the first seven days of operation. Typically, set-up times averaged about 45 minutes and involved 2 or 3 staff. On several occassions the work was performed while wearing

the chemical respirator and gloves. The LSS set-up procedure was to:

a. drive to 200 meter, 1800 meter and 760 meter (upwind) positions and unload equipment from vehicle. Remove components from packing case;

b. erect base plate, support stand, CAM bracket assembly. Anchor stand assembly with 3 stakes and rope;

c. attach 2 CAMs, RF unit and antenna, sensor station interface unit. Connect electrical cables. Confirm correct RF channel frequency;

d. connect 12 volt gel-cell battery to sensor station interface with cable;

e. assemble and attach sunshade; and

f. remove CAM inlet cover, place on new inlet collar and test CAMs with confidence tester. Confirm via radio with CCU monitor. Return to the 500 meter berm.

Simultaneously with the LSS set-up, the CCU was positioned atop the 500 meter berm for good line-of-sight RF communication. This was accomplished by one person in about 15 minutes. The CCU set-up entailed:

a. off-loading the packing case from the vehicle, uncrating the CCU and positioning it atop the berm;

b. removing the side panels and connecting the battery flying lead cable and RF unit;

c. starting the diesel generator and connecting power via extension cord;

d. turning the system on and observing the display to ensure all 8 LSS were functional.

At the end of each day, equipment was dismantled, packed away in the vehicle and returned to Base Camp. Following the establishment of site security, the system was left in place for the remainder of the operation. Daily shut-down then consisted simply of manually turning off the CAMs, discarding the used inlet collars, replacing the inlet

cover and detaching the battery cable from the sensor station interface. On several occasions following rocket destruction it was necessary to turn the LSSs off for the night using the CCU as a result of downwind contamination and a lack of time to perform a manual shut-down due to return helicopter departure for Baghdad. It should be noted that in a number of instances, the work day was abruptly shortened due to an early return to Baghdad as a result of bad weather expected en-route to Baghdad. In a few instances work was also curtailed because Iraqis requested the flight return before dark. A couple of the return flights were so precipitous that personnel were required to doff their IPE in-flight!

B. CAMs

Sixty CAMs were available for rotational use on the CADS. Sixteen CAMs were employed with this system at any one time, and in addition, up to 6 more were distributed among sub-team members for monitoring duties at both work sites.

Previous experience in the Persian Gulf during Operation Friction had indicated that the CAMs received from long-term storage would not respond properly to agent challenge unless they had been previously equilibrated (a process referred to as "burning-in") by continuous running for up to 24 hours or more. This was difficult to do using the lithium sulfur dioxide batteries that are quite expensive and have running lives of only 16-18 hours. As a result, DRES had designed and built power bars that were capable of burning-in 4 CAMs at a time using external power. These power bars were used successfully in the Persian Gulf and two were deployed to UNSCOM 29. Eight CAMs were continuously "burned-in" for rotational use using these 2 power bars. This system completely eliminated the start-up-from-storage problem with CAMs.

C. MASS

The MASS was developed for DRES during the 1980's to replace impinger bubblers for sampling volatile agents during field trials on the Experimental Proving Ground (EPG), and is currently marketed by CCAI (Canadian Centre for Advanced Instrumentation, Saskatoon, Saskatchewan). The system is not designed for abusive handling or exposure to the elements, and consequently it was unknown how the system would operate under the harsh conditions expected in Iraq.

The MASS deployed consisted of 8 sampling stations complete with stand, sampling head, controller, RF unit and battery. Several erasable, programmable, read-only-memory (EPROM) cards were provided so that the sampling timing sequences could be set manually prior to rocket destruction. It was decided to use manual operation because of the known unreliability of the RF remote starting units (no way to verify sampling unit is on following RF transmission except by visual inspection). Only 3 MASS were erected at the 200 meter position 9 March for the last two weeks of rocket destruction operations. This was because there was no established method to return the minitube samples to DRES for analysis, and it was agreed that any samples collected would be virtually useless after three weeks due to decomposition/desorption of agent from the minitube Tenax TA adsorbent. The minitube carousels containing collected samples were sealed in plastic and returned to DRES in personal luggage. This expedient method was not considered hazardous due to the extremely minute amount of adsorbed agent (picogram quantity) held by the minitubes.

The set-up procedure involved:

a. digging a hole to anchor the sampler head support pole base; inserting the support pole into the base and attaching the sampler head; and

b. setting out the controller unit and connecting the cabling to the sampler head and the battery power pack. When ready to begin sampling:

i. insert the appropriate EPROM card into the controller, close the door and press the arm button. This would rotate the minitube carousel to the start position; and

ii. attach the initiator cable and activate the system by pressing the hand-held manual initiator button.

D. SAMPLING KITS

Two DRES-developed chemical sampling kits and 5 teel "castles" for sample transportation were deployed with the DRES team. These kits were used on several occasions for sample collection (water, soil). Collected samples were to be shipped back to DRES in the castles (containing charcoal fill) for retrospective analysis.

EQUIPMENT PERFORMANCE AND RECOMMENDATIONS FOR IMPROVEMENT

A. CADS II AND CAMs

The CADS II system worked exceptionally well during UNSCOM 29 and considerable interest was taken in its operation by member nations and especially the Iraqis. The system withstood the considerable physical abuse involved in the daily assembling, dismantling and transport over rough terrain. The system was also continuously exposed to the elements - wind, rain, sun and sandstorms. Temperatures varied from a low of near 0°C at night with heavy dew to daily highs up to 35°C. Relative humidities varied from highs around 60% in the mornings to lows near 12% in the afternoons. A significant amount of rainfall also occurred during the destruction operations.

The major weaknesses in the CADS were those related to the CAMs. In the cool mornings, CAMs were slow to respond to confidence testing following system start-up. Only a few CAMs were replaced due to failure to respond in G mode at all. The importance of confidence testing CAMs cannot be overstressed due to their unreliability and the fact that even when they are on-line and appear to be running normally, they could in fact be "sleeping". It was also discovered that the CAM responded in the G mode to the smoke/vapours issuing from the burning fuel used to incinerate the rockets. This fuel was a diesel/gasoline mix (25:75), and a maximum of one bar was recorded on CAMs exposed to the smoke from this burning fuel. The maximum response from CAMs at the 200 meter line following detonation was 3 bars. Responses were obtained on 6 out of 15 consecutive detonations. No responses were obtained from the 1800 meter stations or the upwind station.

It is recommended that work continue in the area of ion mobility spectroscopy (IMS) to eventually eliminate inherent CAM weaknesses and make the system more discriminating.

In addition to the CAMs, some minor changes are recommended for future upgrades of the CADS. None of these are critical to the system and do not impact upon operational function, but are intended for the enhancement of the operator/machine interface. These are:

a. provide a sunshade for the CCU liquid crystal display. It is very difficult to read in bright sunlight;

b. replace the CCU side panel retaining screws with some other retention device. The retaining screws were often difficult to loosen when contaminated with dust/sand, and would often cross-threaded when dirty. The problem is compounded if wearing gloves. Perhaps larger "wing nuts" or a hinge such as piano hinge should replace the retaining screws;

c. replace the channel selector switch on the RF units with a lower profile knob. One RF unit had its selector switch bent during transit. In addition, the switch is difficult to use when wearing gloves due to its small size and proximity to the antenna connector;

d. CAM electrical power supply should have the protruding ON/OFF toggle switch recessed or changed to a PUSH ON/OFF. One power supply had the ON/OFF switch broken during transit;

e. the CADS II LSS metal packing cases should be rustproofed or manufactured from impact resistant plastic. The packing cases started to rust after being left exposed to the elements for a few weeks; and

f. the CADS II LSS sunshade should be "oversized". In a few instances it was difficult, and in some cases impossible, to fit the sunshade over the shade support rods due to too small a canopy. It is suggested that the shade corners be elasticized for easier fit over the ends of the support rods.

B. SAMPLING KITS

The sampling kits were used on several occasions to obtain samples of water, soil and rocket chemical agent fill for retrospective analysis at DRES. The kits were considered adequate for the job, however the following recommendations are made to enhance the effectiveness of the kit:

a. consideration should be given to enlarge the sampling kit to incorporate the separate liquid, vapour and biological kits into one. Also, more sample vials are required in the kit. Suggest increasing the number of vials from 6 to 10.

b. although not a direct result of the kits' use in Iraq, it is understood that medical "vacutainers" are used by the Netherlands in their sampling kits for easy liquid collection. These universal items should be evaluated for inclusion in the DRES sampling kit.

The most serious problem that affected the sampling process was the fact that the samples gathered could not be air lifted back to DRES due to a lack of approved procedures for shipment of such material. As a result, none of the samples gathered, with the exception of the MASS minitube carousels, were returned to DRES for analysis. The samples were taken by the French Team Leader to be analysed at the Institut D'Etudes le Bouchet near Paris, France. It is doubtful whether Canada will receive the findings of any analyses carried out. It is recommended that SOPs be established within the CF for the handling and transport of such materials as the' ·ply to the collection for analysis of unknown samples gathered for verification purposes. Such SOPS would also be relevant to the transport of unknown chemicals retrieved from the NBC battlefield in accordance with STANAG 4359.

C. MINITUBE AIR SAMPLING SYSTEM

As alluded to earlier, the MASS was developed for DRES as a scientific system for use in field trials on the EPG. As a result, it was never ruggedized for military use, nor did its concept of use include lengthy exposure to the elements. The system was deployed to Iraq as an expedient means of gathering downwind samples post-detonation for retrospective analysis at DRES. As a result, any criticism of this system is not applicable, as it was not used within its design considerations. The system did work reasonably well once "debugged", and air samples captured by the minitubes were subsequently analysed at DRES and found to show evidence of GB/GF nerve agent.

It must be determined whether this system has any future use with the Canadian Forces before any attempt is made to ruggedize the system. Should it be decided to do so, the system would require redesigning to meet military specifications and ruggedization to withstand exposure to the environment and rough handling.

D. OTHER EQUIPMENT

a. Protective Equipment

The Canadian team was issued with CF equipment drawn from the CF Supply System on a temporary personal loan - boots, web belt and canteens, KFS set, laundry bags, flashlight, insect repellent, barrack box. The insect repellant was subsequently never used because it contained DEET, a substance known to affect the CAM. This item should be removed from the CF Supply System due to its incompatibility with chemical operations. Standard CF NBC land forces protective overgarment, butyl rubber boots and gloves and the C4 mask were used while working in contaminated areas. Military clothing was not authorized for Operation Forum, and personal improvisation was the rule. Many personnel purchased loose-fitting coveralls in Bahrain which provided comfortable non-restrictive clothing for field use. Other individuals wore clothing such as jeans and T-shirts while on-site. The UN provided only a sunhat. Proper non-restrictive, non-military clothing should be provided either by the UN or by home units for this type of operation.

Mask seal testing in the field was conducted on-site every morning. This was effectively done by having each individual don the protective mask and a vial containing cotton wadding soaked with banana oil (amyl acetate) was wafted around the mask seal. This is the same procedure used at DRES to test mask seals.

b. Medical

For medical prophylaxis and therapy, Canadian members were issued with nerve agent pretreatment (NAPs) (pyridostigmine bromide tablets), HI-6 autoinjectors, anticonvulsant therapy (pro-diazepam autoinjectors), reactive skin decontaminant, doxycycline antibiotic and immodium (which proved particularly useful to some individuals). NAPs contributed to cases of diarrhea in some sensitive personnel, and this problem was compounded by the absence of toilet facilities on site. Doxycycline created skin photosensitivity problems in some personnel, and it was replaced with ciprofloxacin. The Canadian team was forbidden by the non-Canadian medical support team to use the HI-6 and anti-convulsant autoinjectors. These were collected by the medics and replaced with the less effective atropine/oxime injector and NAPs. The rationale for this was that the medical staff were not familiar with HI-6 and were therefore not knowledgeable about how it may interact with their

medical treatment for nerve agent exposure. The chief medical officer very bluntly stated that he would refuse to treat anyone who had taken HI-6. This caused considerable consternation among Canadian members, especially considering that there was some question about the efficacy of the atropine/oxime autoinjector against agent GF. Following a discussion with DRES, the Director of Medical Operations (DMO) at National Defence Headquarters, Ottawa, advised the team members to comply with the medical officer's request.

The following recommendations are offered for consideration:

a. a lighter-weight NBC IPE ensemble is urgently required for work in hot climates. Temperatures reached a maximum of 35°C during UNSCOM 29 activities and are known to exceed 50°C;

b. goggles are required for use in desert areas where blowing sand presents a hazard to the eyes. These should be available through the CF Supply System;

c. a plastic disposable sun-shade or preferably tinted "wrap-around" sun glasses are required for use with the C4 mask in bright sunlight, especially where the eyes may be dazzled by light reflecting off white sand;

d. developing of disposable plastic prescription lenses that may be fitted to the exterior eyepieces of the C4 mask should be investigated. The use of under-the-mask combat spectacles for prolonged periods of time in a hot and chemically contaminated environment is not considered adequate;

e. steps should be undertaken to enlighten allied nations regarding accepted Canadian medical treatment procedures. Canada will likely be involved in future operations of this nature with multinational peacekeeping forces, and Allied forces should accept equipment and medical procedures adopted by Canada to protect her personnel; and

f. a simple and effective method should be developed by the CF for personal testing of the NBC mask seal in the field, and it is recommended that amyl acetate (or suitable alternative such as

methyl salicylate) in a miniature aerosol dispenser (or pump) be developed for personal issue. Currently, a soldier in the field who must quickly don his NBC mask in preparation for a "gas attack" has no way to verify that the seal is adequate.

OTHER DEPLOYMENT FACTORS

Canadian personnel deployed with UNSCOM 29 were given very late notice of tasking. The UN requested Canada's participation by letter dated 27 January 1992. Formal discussion over team composition delayed the initial DRES participation warning order from National Defence Operations Centre (NDOC) Ottawa until 6 February. "Nominees" were informally advised of their participation on 7 February, and formally confirmed of their departure on 11 February, about 30 hours prior to actual departure. This late notification created considerable confusion and consternation among those individuals selected as they scrambled to make last minute administrative and medical arrangements. The late flurry of telephone calls and, at times, contradictory messages to DRES from J3 Operations National Defence Operations Centre (J3 Ops/NDOC), National Defence Movements Control Centre (NDMCC), J4 Logistics National Defence Logistics Control Centre (J4 Log/NDLCC), J3 NBC, Director Movements (DMOV) and Chief of Research and Development (CRAD) served to confuse matters. Transportation details were not finalized until less than 24 hours prior to departure.

The Canadian team deployed on UNSCOM 29 was transported by military freighter aircraft with their equipment. This resulted in five days of travel to reach Manama, Bahrain, from DRES. This, in addition to passing through 10 time zones and working 28 days with only one day of rest, created considerable chronic fatigue and often contributed to dissatisfaction with conditions in the field, such as a lack of sanitation facilities and a requirement to extend the mission due to a discovery of additional buried rockets. As a result of this last-minute increased workload, programmed rest periods were cancelled in an attempt to maintain the original time-table. This in itself created dissatisfaction because it was considered that this additional work was beyond the mandate of UNSCOM 29 which was created to destroy only those rockets retrieved from the Khamisiyah Depot and placed on the ground at the "storage" site. The final tally on ordnance destroyed amounted to 425 rockets and warheads with agent fill and 38 rocket motors. A halt was called to the mission before all buried rockets were excavated, and a future mission will have to determine

the numbers remaining and their condition before deciding on how they are to be destroyed. All personnel, especially civilians not accustomed to such working conditions, should be well-briefed prior to deployment on the possibility of mission extensions in the field and the spartan living and working conditions that may be encountered. Individuals should also understand that some situations that they may be exposed to may create considerable stress. This was exacerbated by the fact that members could not easily communicate with family. Using the limited Iraqi telephone system cost over $10.00US per minute, assuming a line was available. Lack of an ability to pass information to family members back home regarding mission extensions added to frustration. Communication with coordinators at NDHQ was also inhibited with the result that NDHQ was quite unaware of team progress, particularly for the making of return trip details such as cargo, sample and personnel airlift. This was complicated by the fact that a number of key personnel in NDHQ who initially handled the deployment operations departed on leave prior to the conclusion of the mission. This created some confusion in the hierarchy for coordinating requirements at the conclusion of the mission, especially the provision of timely information to the team in Iraq.

GENERAL DISCUSSION

The Canadian sub-team was required to support operations at both the rocket storage and rocket destruction sites in addition to its primary requirement to deploy, operate and maintain the CADS II and MASS to monitor and obtain downwind air samples. It is considered that had the team been smaller than the 6 Canadian personnel deployed, it would have been unable to perform these duties effectively. The team was fortunate to have had one UN-experienced member, and therefore had made effective pre-deployment equipment planning. It must be understood that personnel deployed in support of UNSCOM missions must be self sufficient. Everything from personal medication to toilet paper should be carried if possible. The DRES team was well equipped to handle the deficiencies of other sub-teams, and was often called upon to provide masks, gloves and boots to other team members, in addition to general sundries such as survey tape, batteries, and marker pens. It should also be noted that the DRES generator was used exclusively to detonate the explosives in the destruction pits due to the failure of Iraqi-supplied equipment.

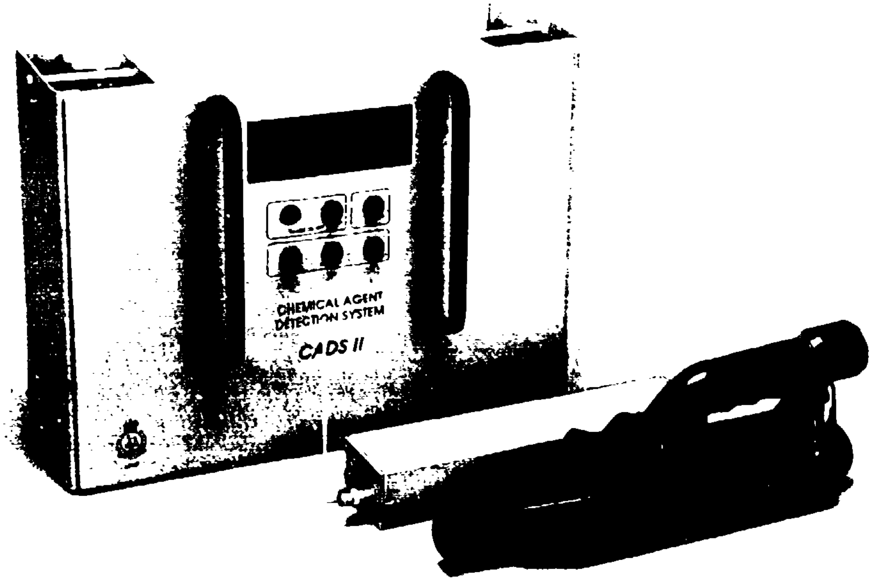
It is concluded that the Canadian Detection, Monitoring and Meteorology Sub-Team was well equipped to

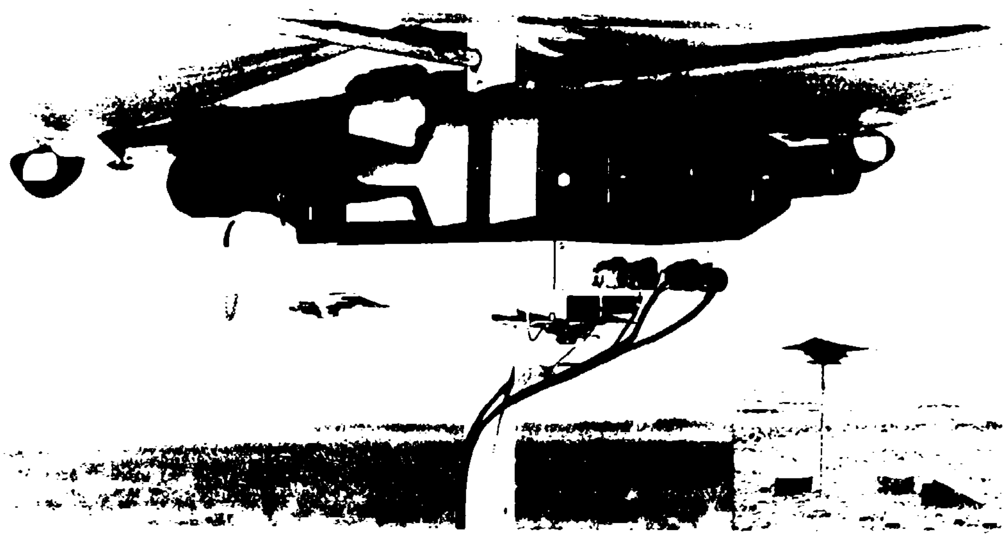
perform its duties, worked effectively during the mission in Iraq and contributed greatly to the overall success of UNSCOM 29. UNSCOM 29 was **not a military operation**, and contained a mixture of civilian and military personnel as has previous UNSCOMs. The mission was hazardous in nature. Since military expertise in destruction operations of this nature is generally non-existent, there will continue to be a requirement for civilian participation in future UNSCOMs. It is therefore important that civilians deployed on future operations be carefully chosen, well-briefed in advance and willing to work under such hazardous and spartan conditions. The attendant details of their deployment should be documented in writing prior to their departure (life insurance, overtime pay, working conditions, miscellaneous expenses such as child care).

A copy of the Detection Sub-Team Final Report to UNSCOM 29 is attached as Annex G.

ANNEX A

CHEMICAL AGENT DETECTION SYSTEM (CADS) II





SIL SCIENTIFIC INSTRUMENTATION LIMITED

SASKATOON, CANADA

[illegible] Herschelman Ave.
Saskatoon, Sask.
Canada [illegible]

Phone [illegible]
Fax [illegible]

CHEMICAL AGENT DETECTION SYSTEM (CADS II)

Scientific Instrumentation Ltd. introduces the second generation of the Chemical Agent Detection System (CADS II) to provide advanced warning against chemical agent attack. This rugged and versatile system establishes a protective warning perimeter around military installations and can also be used to monitor chemical agents at storage and disposal sites.

BENEFITS

- Remote unmanned sensors reduce the risk to armed forces personnel.
- Rugged design and fully portable, the system is easily assembled and disassembled for use in mobile military operations.
- Automatic unmanned operation means a reduction in manpower dedicated to chemical monitoring.
- Uses NATO issue Chemical Agent Monitor (CAM) as the sensing units.
- No special tools are required for set-up.
- Integrated power system for uninterrupted use.
- Simultaneous mustard and nerve agent detection capabilities.

SUPERIOR FEATURES

- Rugged military design.
- Packaged to facilitate easy transportation.
- Sampling stations can be positioned up to 4Km from the Central Control Unit.
- Radio Frequency (RF) link or twisted wire (TW) data communication between sampling stations and the Central Control Unit.
- Adaptable design for expanded operations.
- The system operates using 115 volts AC, 220 volts AC or 24 volts DC.
- Remote sensor stations equipped with solar panel power supply.
- Internal battery back-up.
- Continuous Central Control Unit display of the status of each of the remote sampling stations, alarm conditions, chemical agent type and concentration.
- On/Off control of each remote sampling station from the Central Control Unit.
- Programmable alarm thresholds.
- High and low level audible alarms.
- External alarm drive.
- User friendly operator interface.
- Additional serial communications port for future expansion.
- Continuous monitoring of up to eight remote sensor stations.

SYSTEM SPECIFICATIONS

CENTRAL CONTROL UNIT (CCU)

Shipping Dimension	15cm x 43cm x 25cm (6" x 17" x 10")
Shipping Weight	23kg (50lbs)
Power Requirements	115 VAC, 220 VAC, 24 VDC
Internal Battery Back-up	Minimum 30 minutes
Operating Temperature	-30 degrees C to +70 degrees C

The CCU supports up to eight remote sensor stations in any combination of RF or TW configuration.

REMOTE LAND SENSOR STATION (LSS)

Shipping Dimensions	104cm x 23cm x 20cm (41" x 9" x 8")
Shipping Weight	16kg (35lbs)
Power Requirements	Powered from CCU up to 1 km Or 12V - 24V DC supply
Optional Equipment	12 volt solar panel c/w 110/220V AC charger

The LSS supports two CAMs per station, one for Mustard and one for Nerve Agents.
A low profile sunshade provides protection for the CAM.

COMMUNICATIONS

Radio Link	6 channels (VHF) Programmable frequency Up to 4 km
Twisted Wire	Up to 3 km

PHOTOS COURTESY OF DEFENCE RESEARCH ESTABLISHMENT SUFFIELD

ANNEX B

MINITUBE AIR SAMPLING SYSTEM (MASS)

MINITUBE™ Air Sampling System

A preprogrammed and automated system used to trap, collect, and analyze airborne contaminants in the form of gases, vapors, and aerosols

- **Cost effective** fully automated system reduces operator error and minimizes servicing

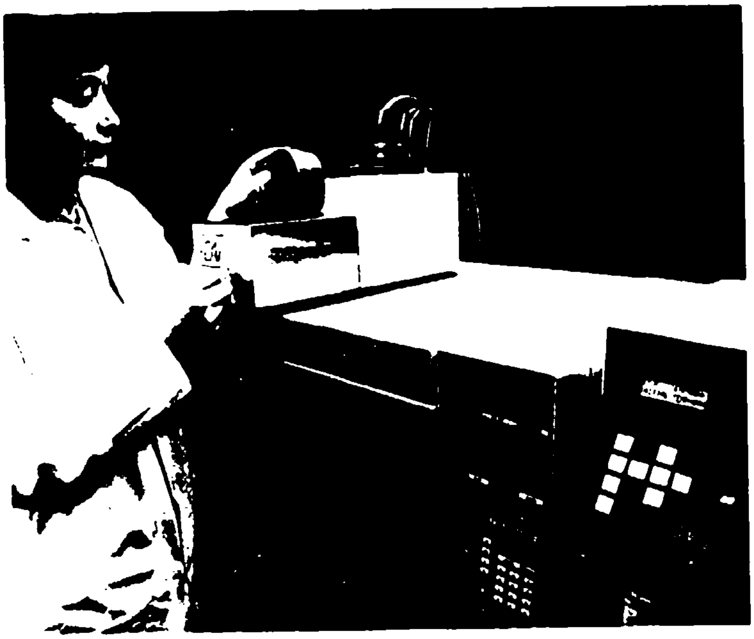
- a maximum of 10 field samplers may be operated from a single controller

- sampling process initiated remotely, by radio transmitter, or locally, with hand-held switch

- analysis facilitated by an automated thermal desorption unit retro-fitted to a commercial gas chromatograph

- a wide range of sampling parameters permits sampling of concentration extremes

CANADIAN CENTRE FOR ADVANCED INSTRUMENTATION



Suggested Military Applications of MINITUBE™ Air Sampling System

1. Sampling/analysis of ambient air inside military collective protection systems to evaluate integrity against ingress of chemical warfare agents.

2. Air sampling/analysis in support of outdoor field trials to determine downwind hazard from explosively-disseminated or sprayed chemical warfare agents and simulants.

3. Air sampling/analysis of vapour evolving from liquid-contaminated surfaces to determine extent of contamination, contact hazard and effectiveness of decontaminants in removing contamination (e.g. CW agents). Such surfaces include vehicles, tentage, runways, aircraft and roadways.

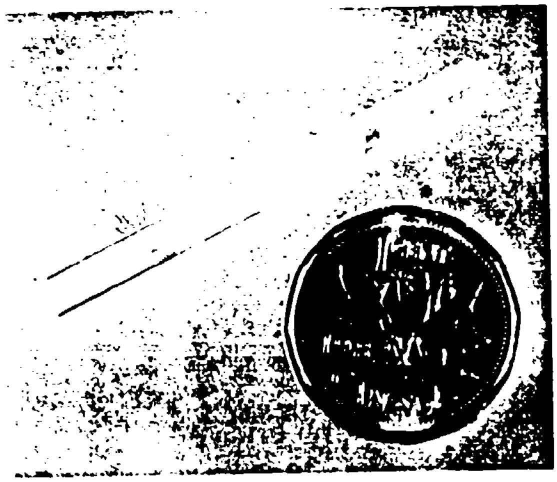
4. Air sampling/collection/analysis to detect and confirm the suspected use of toxic agents in battlefield environments. Timely collection and analysis of known and unknown agents assists in determining the type and extent of protective measures which must be taken to counteract the usage of such agents.

5. Breath analysis as a means of detecting the presence of drugs and their metabolites which could affect human performance under stressful situations.

6. Monitoring workplace air quality to ensure workers safety (e.g. chemical storage areas, ammunition depots).

Designed with the Canadian Department of National Defence

The tested and proven system is a product of the Canadian Centre for Advanced Instrumentation (CCAI), designed in cooperation with scientists from the Canadian Department of National Defence. The MINITUBE™ Air Sampling System replaces bubblers and manual analysis, a system found time consuming and restrictive in terms of overall analysis.



Typical specifications

(Sampler with Controller) •

Power: AC Power (115 VAC/230 VAC) with battery back up or stand alone battery powered

Ambient Temperature Range: -5 °C to 40 °C

Carousel Capacity: 50 Samples

Flow Rate Range: 50 to 100 ml per minute

Sample time: seconds to hours

Minimum Dead Time Between Samples: 5 seconds

Sampler Size: 33 cm x 23 cm x 13 cm

• System can be customized to your specifications

For additional information contact
Canadian Centre for
Advanced Instrumentation
15 Innovation Blvd
Saskatoon, Saskatchewan
S7N 2X8
Telephone (306) 933-7066
Telex SARECO 074-2484

CANADIAN CENTRE FOR
ADVANCED INSTRUMENTATION

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MINITUBE™ AIR SAMPLING SYSTEM
FIELD AIR SAMPLER (MODEL SAM)

SYSTEM DESCRIPTION

The Minitube Air Sampler (Model SAM) is a field based microprocessor controlled air sampler. It is designed to accommodate the Minitube carousel, which contains 50 minitubes. Parameters such as sampling time, wait time between samples and flow rate can be specified by the operator.

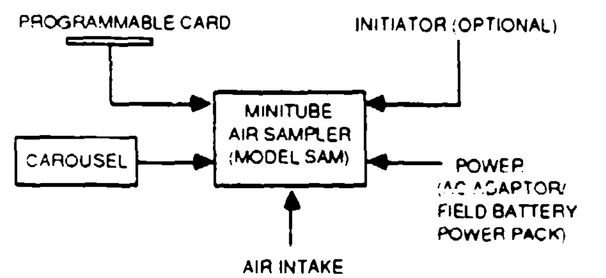

FIGURE 1 MINITUBE AIR SAMPLER (MODEL SAM) SYSTEM LAYOUT

The operation of the air sampler is automated for reliable sampling with minimal operator input. After the operator inserts the removable carousel, the sampler is activated by either turning the power on or setting a command switch on the optional handheld initiator. The sampler will then step through the pre-programmed sequence without additional operator attention. Upon completion of the sampling sequence, the operator can remove the carousel, which will be taken to the lab for analysis, and re-start the sampler for the next series of tests with a new carousel.

The programming sequence is contained on a removable card that is located on the sampler. A number of sampling sequences (or libraries) on each card allows flexible operation. The cards can be programmed to the operator's specifications by CCAI or alternately, the operator can purchase CCAI's Programmer which will allow on-site programming capabilities. The sampler can be operated from an AC adapter or field battery power pack.

GENERAL SPECIFICATIONS

Power: AC Power (115/230 VAC) or field battery power pack
Operating Temperature Range: -5°C to 40°C
Carousel Capacity: 50 Minitubes
Flow Rate Range: 50 to 100 ml/minute
Sample Time: Seconds to 23 hours
Minimum Dead Time between Samples: 5 seconds
Sampler Size: 33 cm x 23 cm x 13 cm

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MINITUBE™ AIR SAMPLING SYSTEM
AUTOMATED THERMAL DESORPTION UNIT (ATDU)

SYSTEM DESCRIPTION

The Automated Thermal Desorption Unit (ATDU) is the analysis component of the Minitube Air Sampling System. The ATDU enables the operator to extract compounds trapped on the minitube adsorbent. The compounds are thermally desorbed by the ATDU and are carried from the minitube to a commercial gas chromatograph, on which the ATDU is fitted. After the compounds are removed, the minitubes can be reused for further sampling.

Parameters related to the analysis cycle can be varied by the operator via an attached IBM PC (or compatible). Desorption temperature and time are among two parameters that can be programmed for flexible analysis cycles. The desorption process is automated, significantly reducing labour requirements and ensuring consistent analysis.

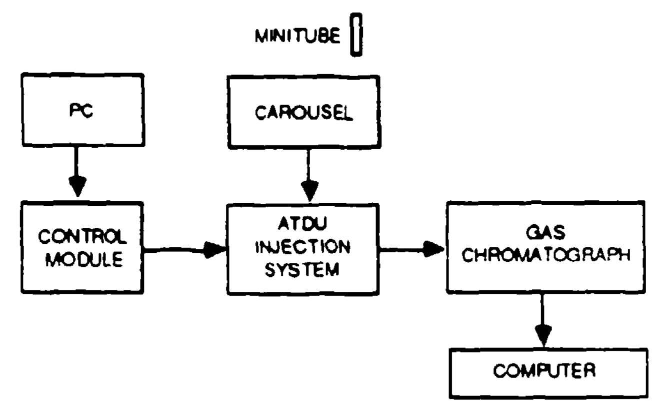


FIGURE 1 ATDU SYSTEM LAYOUT

A schematic layout of the system is shown in Figure 1. The ATDU thermal block and tube extraction mechanism is mounted on a commercial gas chromatograph. Control is provided by a microprocessor based module. The attached PC is connected to the control module and provides a convenient method for parameter programming and control.

GENERAL SPECIFICATIONS

Power: AC Power (115 VAC - optional 220 VAC operation)
Air Supply: 80 - 100 psi
Desorption Temperature Range: 50°C to 250°C
Desorption Time: Up to 99 minutes per phase
Number of Minitubes per Desorption phase: 1 to 50
Communications: Standard RS-232C serial port
Standard GC Fittings: Varian Model 3700, VISTA 6000 and 6500, HP5890 series. Modification kits are available for other models.

ANNEX C

DEPLOYMENT CHRONOLOGY

CADS II AND MASS DEPLOYMENT SCHEDULE

a. 11 February - road move of equipment to Canadian Forces Base (CFB) Edmonton for furtherance to UN Headquarters at Manama, Bahrain;

b. 12 February - road move of 4 DRES staff (2 military officers and 2 civilian technicians) to CFB Edmonton;

c. 13 February - departure of equipment and staff to CFB Trenton, Ontario, via CC-130 Hercules cargo aircraft;

d. 13 February - departure of equipment and staff to Lahr, Germany, via CC-137 freighter aircraft;

e. 17 February - departure of equipment and staff for Manama, Bahrain, via CC-130 Hercules cargo aircraft. Team augmented by two military personnel from Canadian Forces Europe (CFE);

f. 17 February - equipment and personnel arrive at UN headquarters (UNHQ) Manama, Bahrain. Three days spent training and performing equipment checks;

g. 21 February - UNSCOM 29 team arrives Baghdad, Iraq, via Laftwaffe C-160 Transal.Two days spent in operations planning and checking equipment;

h. 24 February - departure for Khamisiyah base camp via UH-53 helicopter. Three days spent preparing the destruction site and practicing procedures. Transportation between Baghdad and Khamisiyah on a daily basis via helicopter;

i. 27 February - commencement of rocket destruction operations. Operations continue until 22 March;

j. 16 March - rocket destruction nearing completion. Three DRES staff and a majority of the CADS II and MASS equipment return to Manama and are returned to Canada 17 March;

k. 23 March - rocket destruction completed. Remainder of Canadian team and equipment sent home.

ANNEX D

UNSCOM 29 OPERATIONAL PLAN

CD1/5/1

See Distribution

7 February 1992

OUTLINE OPERATIONAL PLAN
UNSCOM 29
CHEMICAL DESTRUCTION (CD)1

Reference:
A. CD1 Outline Operational Plan dated 24 January 1992.
B. CD1/31/1 dated 4 February 1992.

THIS OUTLINE OPERATIONAL PLAN SUPERSEDES REFERENCE A WHICH SHOULD BE DESTROYED.

Background

1. The Iraqis have recovered approximately 300, of an original 2160, 122 mm rockets, complete with motors, from a demolition damaged bunker at Khamisiyah Depot. It is believed that as few as 50 of the recovered rockets may still contain their 6.4 litre sarin fills.

2. As a consequence of the unstable condition of the rockets the Iraqis were asked to submit a proposal for their on-site destruction under UNSCOM supervision. Their proposal while acceptable in principle was flawed in detail, therefore UNSCOM experts have provided alternative methods which will be compared on CD1.

Objectives

3. The objectives of CD1 are:

a. To supervise the safe Iraqi destruction of the 122 mm rockets with minimal environmental impact.
b. To compare the relative effectiveness of the alternative destruction methods.
c. To monitor for any contamination and if detected effect remedial action.
d. As far as it is safe to do so assess the health and environmental threat posed by the damaged bunker and recommend a solution.

Principles

4. Destruction operations will be carried out by Iraqi personnel under rigorous UNSCOM supervision.

5. Safety standards adopted will apply equally to both Iraqi and UNSCOM personnel.

6. All personnel at risk of exposure to liquid agent contamination will wear impermeable chemical suits and appropriate respiratory protection equipment.

7. The maximum number of personnel at risk of exposure to simultaneous liquid agent contamination will be 4.

Team Composition

8. The team will comprise an Advance Party which will deploy to Iraq on 16 February 1992 to monitor the progress of the on site preparatory work, and a Main Body which will deploy on 21 February 1992. The composition of the Team is as follows:

a. Advance Party

1) Advance Party Team Leader/ Medical Support	- Nigel Murray
2) Demolition/EOD Team (Deputy)	- Klaus Kessler
	- Dieter Lenkeit
3) Detection/Decontamination team	- Claes Elvhammar
	- Per-Ake Kristensson
4) Interpreter)	- Nominated
5) Video/Photographer)	by UNSCOM Baghdad
6) Communications	- Robert Milosevic
7) Sub Total	8

b. Main Body

1) Team Leader	- Michel Desgranges
2) Deputy	- Igor Mitrokhin
3) UNSCOM Representative	- Agnes Marcaillou
4) CD Operations Adviser	- Garth Whitty
5) Detection Team	- TBN
	- TBN
	- TBN
	- TBN
	- Erwin Kohler
6) Decontamination	- Kjell Savidgrem
	- Bo Koch
7) Medical Support	- Stuart Wilson
	- Murray Hamilton
	- Brian Rundle
	- FNU Fitzgerald
	- Tim Crowe
8) Sub Total	16
9) TOTAL	24

Concept of Operation

9. The chemical destruction operation will be conducted in 9 phases. (Phases 2 - 7 will be repeated for each day's destruction activities.)

a. Phase 1

(1) Confirm all work areas are clear of UXO.
(2) Site preparation including construction of destruction pits. Proposed deployment of advance party to oversee.
(3) In-country training.

b. Phase 2

(1) Confirm suitable meteorological (met) conditions.
(2) Establish control point.
(3) Establish medical support.
(4) Establish decontamination support
(5) Establish detection and monitoring support.
(6) Fill fuel tanks. Method B only.
(7) Move rockets into destruction pits.
(8) Deliver explosives to destruction pits.

c. Phase 3

(1) Prepare rockets for destruction.
(2) Confirm hazard area is clear of personnel and livestock.
(3) Reconfirm met conditions. Prior to opening fuel valve in method B.

d. Phase 4

All personnel withdraw to beyond explosive/agent hazard area.

e. Phase 5

Fire destruction charges.

f. Phase 6

(1) Check site for contamination.
(2) Confirm all charges detonated.
(3) Confirm all rockets destroyed.

g. Phase 7

(1) Decontaminate as required.

(2) Begin individual destruction pit site restoration as appropriate.

h. Phase 8

(1) Complete site restoration.
(2) Effect safe reconnaissance of damaged bunker.

i. Phase 9

Withdraw from Khamisiyah.

Method of Destruction

10. Rockets with motors but without agent fill will be destroyed explosively. Two methods of destruction have been approved for rockets with agent fill and will be compared for relative effectiveness.

(a) Method A. In Method A destruction of the rocket and agent will be achieved explosively.

(1) 5 rockets will be destroyed in the initial firing, up to 10 for each subsequent firing.

(2) The ratio of explosive to agent will be 8:1.

(3) The rocket motor and warhead will be destroyed simultaneously.

(b) Method B. In method B explosive charges will be used to open the warhead, destroy the rocket motor and initiate the fuel held in the reservoir beneath the rockets. The ensuing fireball will destroy the agent.

(1) 5 rockets will be destroyed in the initial firing, 10 for each subsequent firing.

(2) The ratio of fuel to agent will be 4:1.

(3) Rocket motor destruction, warhead opening and fuel initiation charge size will be on advice of the deml/EOD team.

(4) The rocket motor destruction, warhead opening and fuel initiation will be simultaneous.

(5) The opening of the fuel tank valve will be the last action of the demolition team as they leave the destruction site prior to firing the charges.

Destruction Pit

11. See Annex A.

Site Layout

12. See Annex B.

Destruction Recording

13. Destruction recording will be in accordance with UNSCOM 12 procedures.

Control

14. Destruction Operation. The Team Leader, or in his absence his Deputy, will after consultation with the appropriate discipline experts decide whether or not to proceed with that day's chemical destruction.

15. Site Safety. The Safety Officer, or in his absence his Deputy, may halt all site activity on safety grounds.

16. Destruction Site. The senior UNSCOM Deml/EOD team member present at the destruction site will be responsible for the supervision of the preparation of the rockets for destruction. The detailed demolition plan is at Annex C.

17. Explosive Safety. The senior UNSCOM Deml/EOD team member will be responsible for supervising the safe carriage and storage of explosives and explosive accessories. The detailed explosive safety plan is at Annex D.

Detection, Monitoring and Meteorology

18. Nerve agent detection and monitoring will be required as follows:

a. Rocket storage site.
b. Rocket destruction site.
c. Route between storage and destruction site.
d. On-site personnel.
e. On-site equipment.
f. At two separate locations in the downwind plume.

19. Micro met data will be required:

a. Before the start of each day's work.
b. Immediately before destruction.

20. The detailed detection and monitoring plan is at Annex E.

Decontamination

21. There may be a requirement to decontaminate the following:

   a. On-site personnel.
   b. On-site equipment.
   c. Contaminated soil.

22. The detailed decontamination plan is at Annex F.

Medical Support

23. The Senior Medical Officer will be responsible for all aspects of medical support including advice on occupational health and safety for chemical weapons destruction. Detailed medical support and occupational health and safety plans are at Annexes G & H respectively.

Accommodation

24. UNSCOM Baghdad will arrange accommodation. There may be a requirement for some personnel to occasionally overnight at Khamisiyah to ensure task completion.

Transport

25. Transport requirement will include:

   a. UN helicopter. Road travel alternative to be planned.
   b. Coaches x 2 (air-conditioned).
   c. 4 wheel drives x 6.
   d. Ambulance x 2.
   e. Vehicle mounted decontamination station - 5T x 1.
   f. Dump truck X 2.
   g. Water tankers (10,000 l) X 2.

26. The detailed transport plan is at Annex I.

Communications

27. The following communications will be required:

   a. Portable Inmarsat satellite terminal.
   b. Secure voice device for telephones/secure fax.
   c. Radio: - VHF handheld x 12/VHF mobile/HF mobile.

28. The detailed communication plan is at Annex J. UNSCOM New York to provide 24 hour contact list.

Equipment

29. All individuals/teams should be in possession of:

a. Personal chemical protection equipment including spares.
b. Such equipment as is required to carry out their duties.

30. Reserve equipment may be deployed from Baghda(. Details to follow.

Stores

31. Requirement for Iraqi supplied stores should be quantified, by senior discipline personnel, and notified in detail to UNSCOM.

32. Requirements include:

a. Explosives.
b. Explosive accessories.
c. Decontaminants.
d. Fire extinguishers.
e. Tents.
f. Fuel.
g. Fire Service B.A. Control Board.) For booking in
h. Personnel control tags X 50.) and out of on-site personnel.
i. Tables/chairs.

Photography

33. A comprehensive photographic record of CD1 is essential. Both video and colour transparency cover is required. A log is to be kept.

Feeding

34. UNSCOM to provide on site meals for UNSCOM personnel.

Water

35. Drinking. UNSCOM to provide drinking water for UNSCOM personnel.

36. Decontamination. 20,000 litres.

Timings

37. CD1 timings by date are as follows:

a. 16 February - Advance Party from Bahrain arrive Habbaniyah Air Base.
b. 17 February - Advance Party moves to Khamisiyah.
c. 18 February - Main Body arrives Bahrain.
d. 19/20 February - Main Body training.

e.	20 February	- On site preparation complete. (See Reference B para 34)
f.	21 February	- Main Body arrives Habbaniyah Air Base.
g.	22 February	- Combined (Advance Party/Main Body) training Baghdad.
h.	23/24 February	- Joint Iraqi/UNSCOM training Khamisiyah. All Iraqi personnel/equipment on site.
i.	25 Feb - 6 March	- Destruction/bunker assessment.
j.	7 March	- Baghdad.
k.	8 March	- Move to Bahrain.
l.	9/10 March	- Report writing.
m.	11 March	- Depart Bahrain.

Point of Contact

38. Garth Whitty
UNSCOM
CD Team
Ext. 3-9039

DG Boothby

D. G. Boothby
Deputy Director of Operations
for Executive Chairman
Office of the Special Commission

Annexes:

For preparation by:
(Complete by - 10 Feb 92)

A.	Destruction Pit.	
B.	Site Layout.	
C.	Demolition Plan.	- Klaus Kessler
D.	Explosive Safety Plan.	- Klaus Kessler
E.	Detection and Monitoring Plan.	- TBN (Canada)
F.	Decontamination Plan.	- Claes Elvhammer
G.	Medical Support Plan.	- Nigel Murray
H.	Occupational Health and Safety Plan.	- Nigel Murray
I.	Transport Plan.	- Kevin St. Louis
J.	Communications Plan.	- Tim Sopp

Distribution:

External:
Action:

Michel Desgranges
Claes Elvhammar
Klaus Kessler
Alastair Livingston
Kevin St. Louis
Igor Mitrokhin
Nigel Murray
Tim Sopp
Canadian Representative

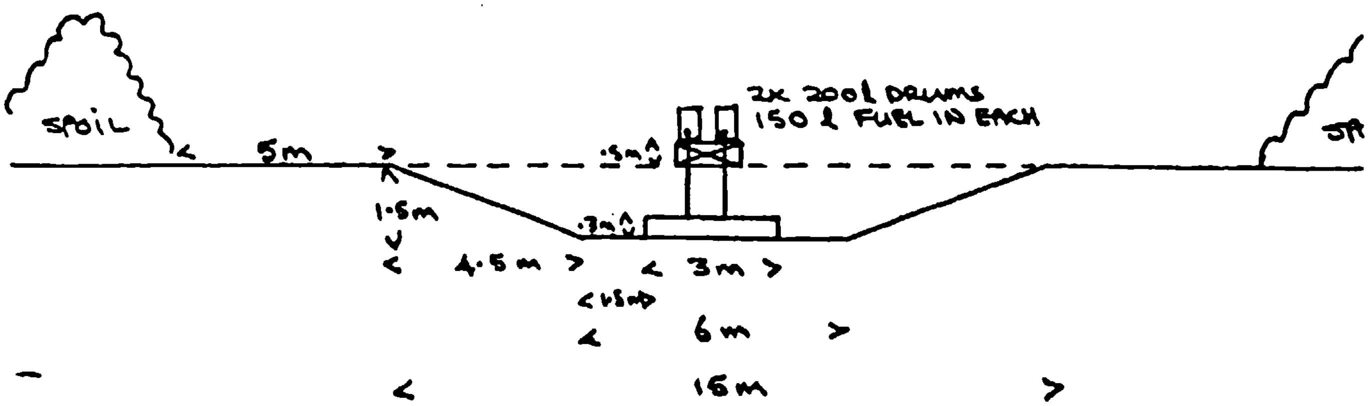
Internal:
Action:

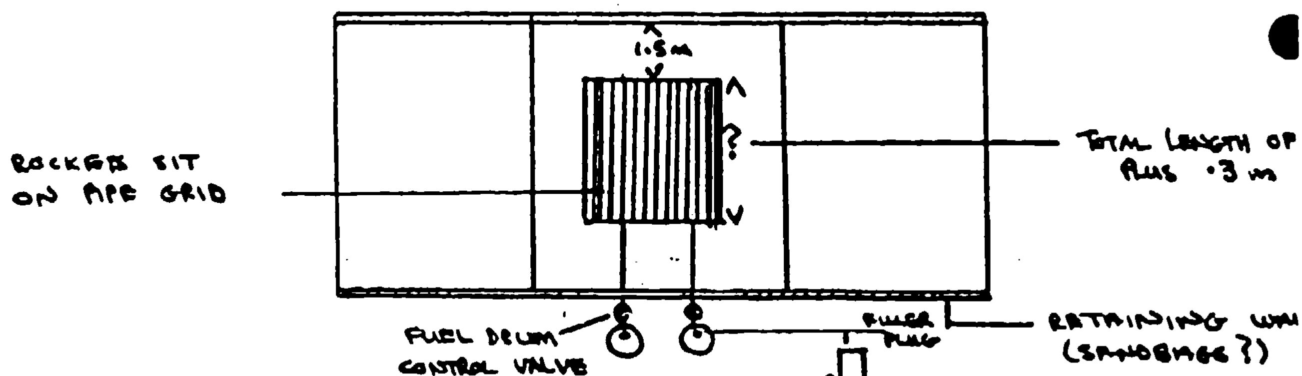
Agnes Marcaillou
Jack Ooms
Johan Santesson
Nikita Smidovich

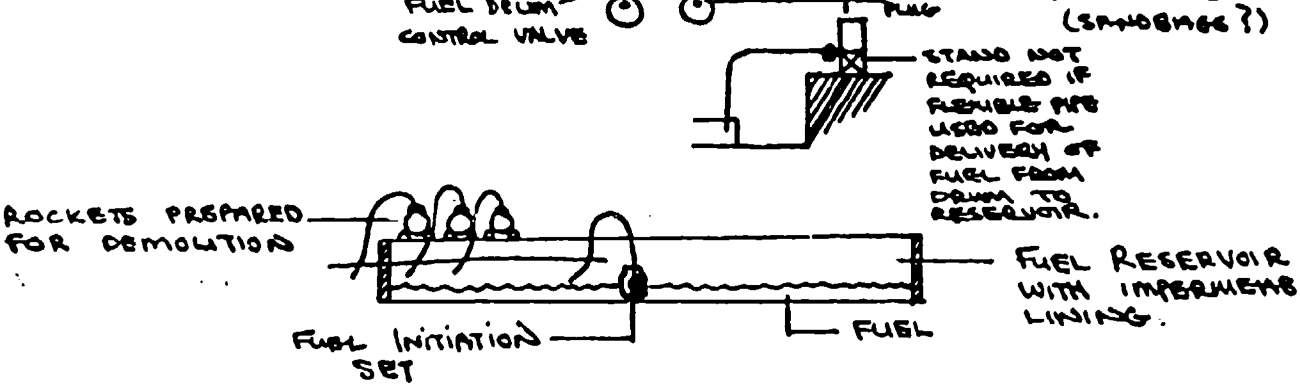
Information:
Bryan Barrass
Derek Boothby
Douglas Englund
Ron Manley

CD1
24 JAN

DESTRUCTION PIT





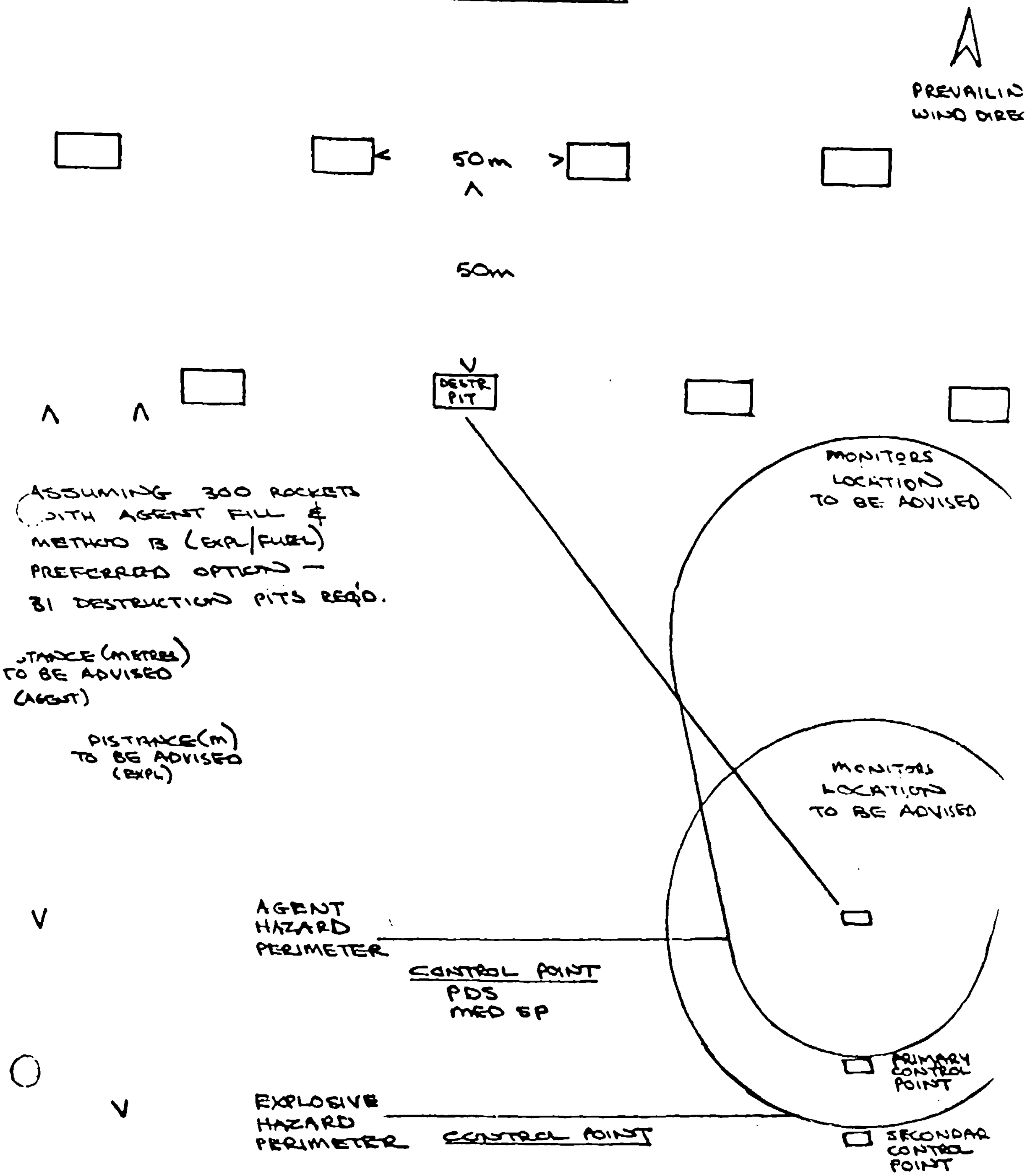


FUEL DRUMS & RESERVOIR WILL NOT BE REQUIRED FOR METHOD A (EXPL) OR ROCKETS WITHOUT AGENT CONTENT.

NOT TO SCAL

CDI
24 JAN 9:

SITE LAYOUT



NOT TO SCALE

ANNEX E

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26. Samih Abu-Faress
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ANNEX F

DETECTION, MONITORING AND METEOROLOGY SUB-TEAM OPERATIONAL PLAN

UNSCOM 29
CHEMICAL DESTRUCTION (CD 1) OPERATIONAL PLAN

Detection, Monitoring and Meteorology

1. Supplied Equipment

The following equipment will be used in support of detection and monitoring requirements during explosive destruction/burning of 122mm GB/GF chemical agent rockets at the Khamisiyah destruction site. Spares will be on hand to ensure the deployed equipment remains operational.

a. Chemical Agent Monitors (CAMs) x8

-for survey of agent contamination and fugitive vapour releases at rocket storage sites, along transportation routes, at the rocket destruction site and on individual protective equipment (IPE).

b. CADS II (Chemical Agent Detection System, Mk II) x1.

-a computer-controlled CADS consisting of 8 separate CAM sampling stations will be deployed downwind of the destruction pits at selected distances (e.g. 300 meters) to warn trial personnel in real time of G-agent vapour hazards existing downwind of the destruction site. A centralized controller/display will be located upwind at the trial control point for safety co-ordination.

c. Minitube Air Sampling System (MASS) x1

- an automated air sampling system based on miniature solid-sorbent tubes housed in carousels which are installed in programmable samplers. Eight (8) samplers with control units will be deployed downwind of the destruction pits at selected distances (e.g. 300 meters) to collect air samples for retrospective analysis of agent vapours, verification of safety templates and development of agent concentration profiles for future destruction operations. The sampler array will be initiated either by radio transmitter or manually depending upon EOD constraints. Sample analysis will be carried out on minitube carousels transported to DRES immediately following the completion of the sampling program. The system will be used to collect samples during at least 10 of the 30 trials planned under UNSCOM 29.

d. Micromet Station x1

- to provide on-site meteorological capability, with read-outs for wind speed, wind direction, temperature at e.g. 2m height and relative humidity. Ground temperature measurement capability is highly desireable. Such measurements will be used to calculate safety perimeters for each destruction operation as well as to

assist in positioning downwind monitoring and sampling equipment.

e. Agent Sampling Kit x1

- specialized kit developed at DRES to collect contaminated environmental samples (solids, liquids, vapours) for retrospective agent- and agent-degradation product analysis. This kit will be used as required to collect selected samples related to the destruction operations.

2. Safety Perimeter

For each rocket destruction operation, a 360° safety perimeter will be established around the site with respect to a) explosive hazards and b) agent hazards. The location of the agent hazard perimeter will depend on the prevailing meteorological conditions at the time of a given destruction operation. The safety distance with respect to agent hazards will be set in a 270° arc downwind of the operation, while the explosives hazard 360° perimeter will be used to set the safety distance upwind of the destruction operation. Examples of downwind safety perimeters under different meteorological conditions are given in the accompanying Tables I and II. These examples apply to the destruction of ten (10) GB/GF-filled 122m rockets by explosive/burning (Method B). Data in Table II represents a worst case scenario where one or more rockets undergo accidental flight during destruction operations.

Several conservative assumptions have been applied in establishing the agent hazard perimeter:

a. The maximum allowable personnel agent exposure limit is 10% of the dosage which causes miosis, or 0.1×2 mg min/m^3 = 0.2 mg min/m^3.

b. Agent GB/GF purity is 100% (actual purity is probably 10 - 30%) and each rocket contains a full load of 6 kg agent (actual load may be less due to leaking).

c. Fuel burning combustion efficiency for GB/GF is 95% (actual combustion efficiency will likely exceed 99%).

d. Insignificant amounts of agent will be released in the short time interval between explosive opening and fuel ignition (Method B).

3. Montoring and Sampling Equipment Deployment

Each CADS station will be co-located with a MASS sampling station. Eight stations of CADS and MASS will be deployed in a 270° arc at 300 m from the destruction pit area in the prevailing downwind direction (4th sampling station directly downwind). Depending on results of first tests, two lines of samplers consisting of 4 sampling stations each may be deployed downwind at e.g. 200m and

500m. Each MASS station can collect up to 50 independent air samples. Five samples will be collected by each of the 8 sampling stations for each trial (40 samples per trial). A total of 10 trials will be sampled in this manner to collect sufficient data on the effectiveness of the destruction methods.
The micromet station will be placed at the trial control point.

4. <u>Proposed Detection and Monitoring Protocol</u>

a. Detection Team installs and tests CADS, MASS and Micromet equipment at the destruction pit site. Background readings are taken with CADS and with portable CAMs to determine pre-destruction conditions with respect to agent vapours (Mustard and G-agent).

b. Detection Team acquires meteorological information for establishment of agent hazard perimeter. Typical agent hazard distances downwind for different atmospheric stability categories and wind speeds are given in Table I.

c. Monitoring pers perform slow approach to storage site from upwind direction using CAMs. Storage site monitored for agent vapours and declared safe for rocket removal.

d. Iraqi pers remove rockets from storage and load on transport vehicle.

e. During loading operation, monitoring pers check site for agent vapours from leaking rockets. Leaking rockets are noted.

f. Iraqi pers are cleared to transport rockets to destruction pit site and place rockets in pits.

g. Monitoring pers check transportation route and transport vehicles for agent vapor sources. Rockets are checked for leaks during off-load at the destruction site. Leaking rockets are noted.

h. If resources permit, a site area overflight is conducted to verify destruction site downwind safety perimeter is clear of unauthorized pers (e.g. Iraqi transients). Detection Team starts MASS samplers manually or remotely.

i. EOD pers cleared to set charges. All other pers to clean/dirty control point.

j. Monitoring pers check all pers clearing destruction site at clean/dirty control point for contamination. Decontamination Team decons pers if necessary.

k. Record final met conditions and ensure safety perimeters are clear. All pers to safe upwind position.

l. EOD pers remotely function explosive charges and (Method B) fuel ignition charges (Destruction Trial time T = 0).

m. After explosion and during combustion (Method B) entry to downwind sampling area prohibited until CADS reads previously-established background readings.

n. When site entry permitted, Detection Team proceeds to CADS/MASS sampling stations, checks equipment, changes minitube carousels if necessary and restarts sampling equipment for next trial.

o. Monitoring pers survey area with CAMs starting from downwind centerline CADS/MASS station in towards destruction pit in slow spiral approach.

p. Detection Team, Monitoring pers proceed to clean/dirty control point for decontamination at end of work period or at any time when IPE contamination is suspected/confirmed.

5. Safety Guidelines

a. Destruction trials will not be run at night.

b. General meteorological and associated conditions for allowing a trial to proceed are:

- NO rain/snow/visibility obscured by (blowing) dust;
- STABLE WIND DIRECTION within 30° arc;
- WIND SPEED between 1 m/sec (approx. 3.5 km/hr) and 15 m/sec (approx. 55 km/hr);
- AIR AND GROUND TEMPERATURE known and recorded;
- SAFETY PERIMETERS established.
- ATMOSPHERIC STABILITY conditions A,B,C and D only

c. There shall be no site entry within the agent hazard perimeter until the downwind CADS clears to pre-destruction background levels. Respirators shall always be worn when conducting area or site surveys where agent contamination is possible. A CAM reading of 6-bars on entry to a site will require all pers to don full IPE prior to entry to the site. Discovery of contamination on IPE will require the per to immediately evacuate to the clean/dirty control point for decontamination.

TABLE I: Safety Distances For Combustion Of 60 kg GB/GF (Method B)

WINDSPEED		SAFETY DISTANCES (km) FOR VARIOUS PASQUILL ATMOSPHERIC STABILITY CATEGORIES			
m/second	km/hour	A	B	C	D
1	3.6	0.41	0.69	1.08	2.10
2	7.2	0.32	0.51	0.74	1.30
3	10.8	-	0.42	0.59	1.03
4	14.4	-	0.36	0.51	0.86
5	18.0	-	-	0.45	0.754
6	21.6	-	-	0.40	0.68
>6	>21.6	-	-	0.40	0.68

TABLE II: Worst Case Scenario -- Safety Distances For Total Evaporation Of 6 kg or 60 kg GB/GF With No Combustion

		SAFETY DISTANCES (km) FOR VARIOUS PASQUILL ATMOSPHERIC STABILITY CATEGORIES							
WINDSPEED		A		B		C		D	
m/s	km/h	6	60	6	60	6	60	6	60
1	3.6	0.52	<1.1	0.94	2.36	1.60	6.2	3.2	16.0
2	7.2	0.41	0.89	0.69	1.80	1.08	4.1	2.05	9.9
3	10.8	-	-	0.58	1.54	0.87	3.2	1.59	7.4
4	14.4	-	-	0.51	1.38	0.74	2.70	1.30	6.0
5	18.0	-	-	-	-	0.65	2.40	1.15	5.1
6	21.6	-	-	-	-	0.59	2.15	1.04	4.5
>6	>22	-	-	-	-	0.59	2.1	1	4.5

Pasquill Stability Category as a Function of Net Radiation Index and Windspeed at 10 Metres

Windspeed m/sec*	Net Radiation Index						
	4	3	2	1	0	-1	-2
<1	A	A	B	C	D	F	F
1	A	B	B	C	D	F	F
2	A	B	C	D	D	E	F
3	B	B	C	D	D	E	F
4	B	C	C	D	D	D	E
5	C	C	D	D	D	D	E
6	C	C	D	D	D	D	D
>6	C	D	D	D	D	D	D

* 5 m/s = 18 kilometres per hour

Net Radiation Index

	Day						Night*			
Cloud Cover (1/8)	0-4	5-7			8		8		7-4	3-0
Cloud Height (1000 ft)		> 16	16-7	< 7	≥ 7	< 7	< 7	≥ 7		
Solar Altitude										
< 15°	1	1	1	1	1	0	0	−1	−1	−2
15-35°	2	2	1	1	1	0				
35-60°	3	3	2	1	2	0				
> 60°	4	4	3	2	3	0				

* Night is defined as the period from one hour before sunset to one hour after sunrise.

ANNEX G

DETECTION SUB-TEAM FINAL REPORT TO UNSCOM 29

UNSCOM 29

DETECTION SUB TEAM

FINAL REPORT

PERSONNEL

1. The Detection Sub Team consisted of seven persons. Their names, country of origin and parent organizations are as follows:

a. Major Al CARRUTHERS, Canada, Defence Research Establishment Suffield (DRES), Canada;

b. Major ERWIN KOHLER, Switzerland, NC Defence Training Centre, Spiez, Switzerland;

c. Captain WAYNE STURGEON, Canada, DRES, Canada;

d. Master Warrant Officer Andy BRUYERE, Canada, Canadian Forces Europe, Lahr, Germany;

e. Warrant Officer Yves ETHIER, Canada, Canadian Forces Europe, Lahr, Germany;

f. Mr. Gary SOUCEY, Canada, DRES, Canada; and

g. Mr. Dean VERPY, Canada, DRES, Canada.

OBJECTIVES

2. a. monitor for any chemical agent contamination of personnel, equipment, vehicles or terrain;

b. collect scientific data which will demonstrate the effectiveness and safety of the method used to destroy chemical agent weapons; and

c. provide on-site surface meteorological data.

EQUIPMENT USED

3. Except where indicated, all of the equipment used for the detection and monitoring of chemical agents was provided by Canada.

PERSONNEL/EQUIPMENT/AREA CONTAMINATION DETECTION

4. The team utilized small portable equipment for the manual monitoring of personnel/equipment and the conduct of area contamination surveys on foot. The equipment used included:

a. Chemical Agent Monitors (CAM). The CAM was the primary detector used for contamination detection of chemical agent vapours. CAM will detect vapours of G, H and V agents;

b. AP2C. A small quantity (3) of the French AP2C detectors were available for the use by medical and detection personnel. They are similar to the CAM in their operational use and capabilities; and

c. Miscellaneous Monitoring Equipment. The following items were available for use for detection purposes. However, CAM use was so extensive that there were few opportunities or reasons to use those items except as a back-up means of detection:

(1) Nerve Agent Vapour Detectors (NAVD). A disposable detector which indicates the presence of nerve agent by a colour change.

(2) Chemical Agent Detector Kit (C2 Kit). Provides relatively quick detection (10 minutes) of known chemical agents. It can also be used to collect small minitube samples of unknown agent vapours.

(3) Detector Paper. This paper, which can be fastened to most surfaces, is used to detect the presence of three liquid chemical agents by colour change, nerve (G and V) and blister (H). Used primarily during area surveys to determine which areas or objects have been contaminated by liquid agent.

REMOTE DETECTION SYSTEM

5. The Chemical Agent Detection System Mark II (CADS 2) system was employed to provide real-time warning to personnel of nerve agent hazard. Remote stations are positioned primarily downwind of the destruction area to detect the presence of nerve agent which may have been released during the destruction of the rocket ammunition. The remote stations relay the information collected by CAMs at each station to a central control unit located at the control point for the

destruction activity. This information was passed via a radio link between the remote sensor stations and the central control unit. A panel at the central control unit displays the presence of any agent at any of the stations and an indication in bars of CAM response of the concentration of the agent. The type of agent is also displayed. An audio alarm was set to sound a warning when the concentration at any station reached or exceeded the 2 bar level. The CADS 2 system was developed at DRES for the detection of G, H and V vapours at fixed installations such as on board ships, headquarters, and airfields.

REMOTE SAMPLING EQUIPMENT

6. The minitube air sampling system is an automated air sampling equipment which collects air samples by pumping air through miniature solid-sorbent tubes. The time that the air is sampled is controlled by a microprocessor which can be programmed to sample at any pre-determined time. Typical sampling times are for 15 minutes and a carousel indexes forward to collect another sample for the next 15 minutes. A total of 5 sampling periods were used during each destruction activity. The air samples thus collected were transported to DRES for retrospective analysis.

MANUAL SAMPLING KITS

7. A specialized kit was developed at DRES to collect potentially contaminated environmental samples (solids, liquids, vapours) for retrospective agent and agent degradation product analysis. This kit was used to collect soil, water and other selected samples related to the destruction operation.

METEOROLOGICAL INSTRUMENTS

8. Portable meteorological equipment was used to provide on-site surface met information which would measure the speed and direction of the wind, ground surface and ambient air temperature, relative humidity, and the information necessary for the calculation of the Pasquill stability category. Equipment used to collect this information included:

a. hand-held anemometer for wind speed;

b. magnetic compass/clinometer for measuring wind direction and angle of the sun;

c. sling psychrometer for ambient air temperature and the calculation of relative humidity;

d. IR pyrometer to determine ground surface temperature; and

e. tables for the determination of the Pasquill stability category.

SAFETY PARAMETERS

9. Annex E to the Chemical Destruction (CD 1) Operational Plan gives the safety parameters which were applied for the determination of downwind safety distances for the destruction activity. These parameters, together with a detailed reconnaissance of the area, resulted in the selection of a site which would have minimal effect on inhabited areas, roads, etc. A large salt marsh which supported minimal vegetation and wildlife was selected as the preferred downwind area and a template which defined the left and right boundaries for the wind direction was established. This template is depicted as Figure 1. The downwind safety distance was calculated by determining the Pasquill stability category and the actual wind speed at the site and referring to tables prepared by DRES and contained in Annex E to the CD1 Operational Plan.

METHOD OF OPERATION

10. Remote Detection System. The CADS 2 system was originally set up with 5 sensor stations 200 metres downwind from the destruction pits and 2 sensor stations 1800 metres downwind from the destruction area. A single sensor station was established between the destruction area and a major inhabited village (Figure 2). There were no detections of any nerve agent recorded by the latter three stations after 8 destruction operations. As a result, these stations were moved closer to the destruction area to provide better coverage in areas where some nerve agent had been detected from the destruction activity. The distance from the closest destruction pit and the sensor station was measured at 110 metres (Figure 3).

REMOTE SAMPLING

11. Three remote minitube samplers were established at CADS sensor stations 2,3, and 4 (Figure 3). These locations were those which recorded the most nerve agent detections after destruction activity. Air samples were collected on 9,10,11, and 12 March 1992. Retrospective analysis will be conducted by DRES.

PERSONNEL/EQUIPMENT CONTAMINATION DETECTION

12. Standard procedures developed for the detection of contamination of military personnel and equipment using CAMs were followed. Each person exiting a potentially contaminated area was monitored by a detection team member at the decontamination point. Persons working in higher hazard areas such as the loading/unloading of munitions and the placement of destruction charges/changes were continuously monitored by a detection team member on-site. Vehicles were similarly monitored for contamination. Any personnel or vehicles showing any signs of contamination were immediately dispatched to the decontamination team for decontamination. Post decontamination monitoring was conducted to ensure that all contamination had been eliminated. Particular care was taken to monitor the hands and feet of personnel, vehicle tires and wheel wells, and the dump bodies of the dump trucks which transported the rockets.

AREA CONTAMINATION SURVEYS

13. Areas in the vicinity of the destruction pits and downwind of the pits were surveyed for contamination after each destruction operation. CADS 2 indicated if there was release of any nerve agent which carried downwind. After the fuel burned off at the destruction pits and there was no indication of downwind contamination, a foot recce was conducted on the pits where the destruction took place. Special attention was given to the actual pits and any warhead debris which might exhibit some nerve agent response from the CAMs.

MANUAL SAMPLING

14. Samples were collected of the soil at the site before and after the destruction operations. In addition, samples of vegetation, water from the canal adjacent to the site, and a nearby marsh were collected to confirm if any environmental damage had occurred. The samples collected were sent to France for retrospective analysis.

TECHNICAL DATA AND DISCUSSION

15. CAM. More than 1500 operating hours were accumulated on the 26 CAMs which were used throughout the UNSCOM mission. They performed reliably, and were easy to operate and maintain. There were two points regarding CAMs which are worth noting:

a. The CAMs often took up to 2 minutes to clear after registering the presence of a G agent. This

prolonged the time required to conduct area surveys and inspection of chemical warhead debris; and

b. The CAMs provided erroneous nerve agent readings of one bar in the presence of fuel fire vapours and/or smoke. Tests conducted with burning fuel showed that the one bar reading could not be exceeded regardless of the time of exposure or concentration of fuel fire products. Therefore, it was assumed that CAM readings of more than one bar were true agent indications. Readings taken in the presence of a fuel fire were suspect if only one bar was indicated.

AP2C

16. Experience with the AP2C was not as extensive as with CAMs, however, the comments generally apply to the AP2C as well as CAMs.

CADS 2

17. The CADS 2 remote vapour detection system performed very well throughout the mission. Since the basic sensors of CADS 2 are CAM units, the problem of suspect readings at the 1 bar level in the presence of fuel fires must also apply to the CADS 2 detections. Table 1 summarized the CADS 2 readings which were observed during the destruction operations. All of the positive indications occurred at the sensor stations located 110 to 200 metres from the points of destruction. It is apparent that G Agent readings were at a relatively low level even at such a short distance from the destruction pits. The one instance where 3 bar readings were obtained was likely due to rockets which were only partially destroyed/burned during the destruction process.

REMOTE AND MANUAL SAMPLING

18. The results of the remote and manual sampling are not available at the time of the writing of this report. When the analysis is complete they will provide additional scientific evidence on the effectiveness and safety of the destruction method employed during UNSCOM 29.

METEOROLOGICAL DATA

19. The met data which was collected during each destruction is summarized in Table 2.

SUMMARY

20. All of the scientific data collected to date indicates that the destruction method employed was both safe and extremely effective at limiting the contamination of the environment.

21. The CADS 2 system performed well under severe desert climatic conditions. It required minimal maintenance and was ideal for its intended purpose of providing remote real-time detection of chemical agent vapours. Such a system is a most valuable safety control when contamination could occur as a result of destruction/disposal of chemical weapons.

22. CAMs and AP2C detectors performed reliably and effectively during the entire operation. Operators had confidence in both equipments.

20 March 1992

A.R. Carruthers

SUB TEAM LEADER

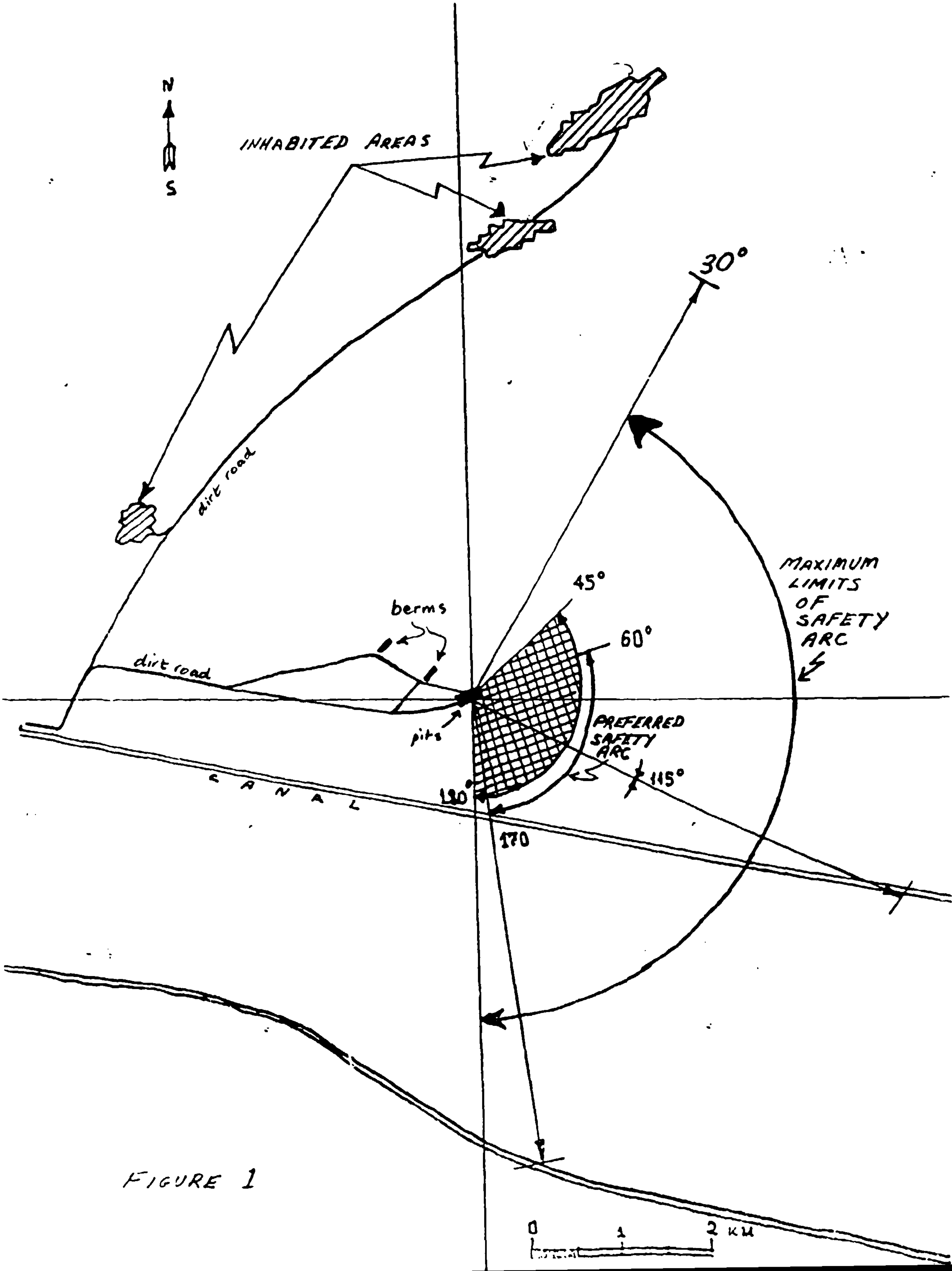
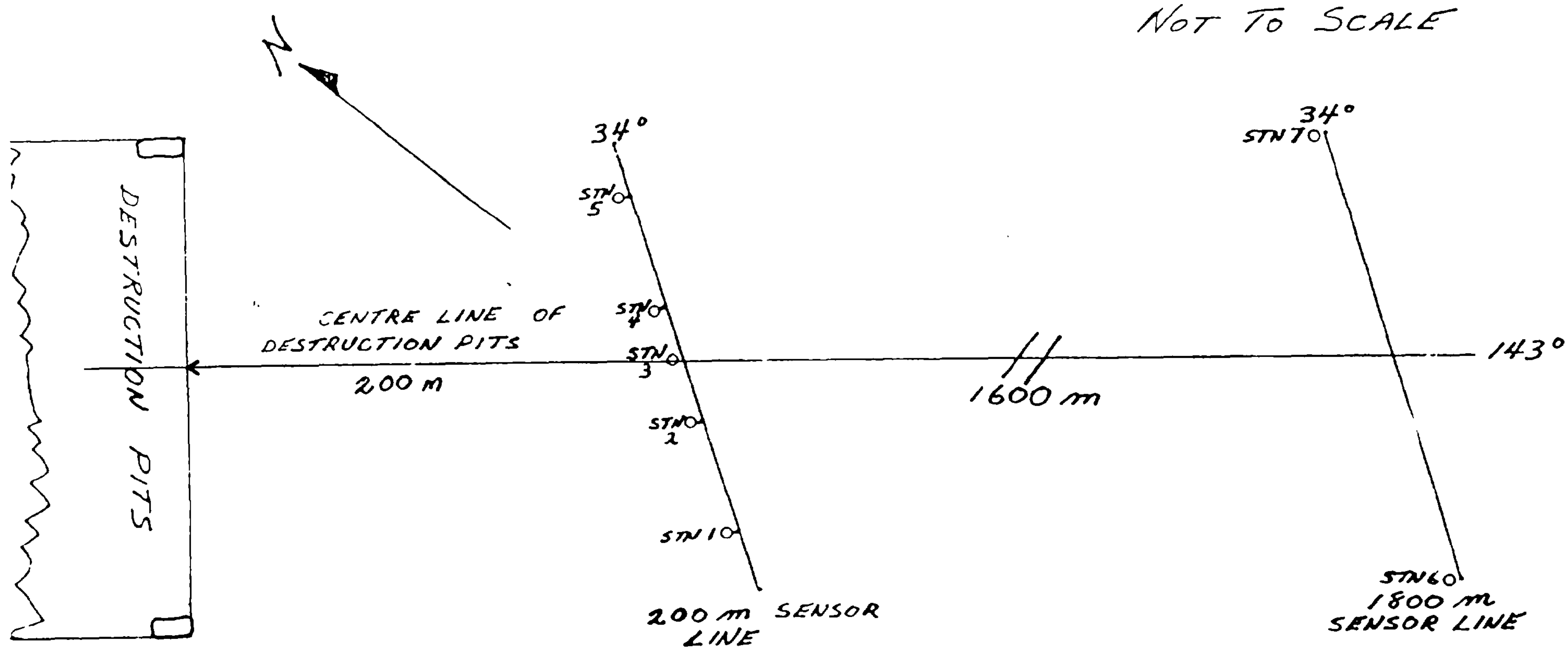

N
S
INHABITED AREAS
30°
dirt road
MAXIMUM LIMITS OF SAFETY ARC
45°
berms
60°
dirt road
pits
PREFERRED SAFETY ARC
CANAL
115°
180°
170
0
1
2 KM

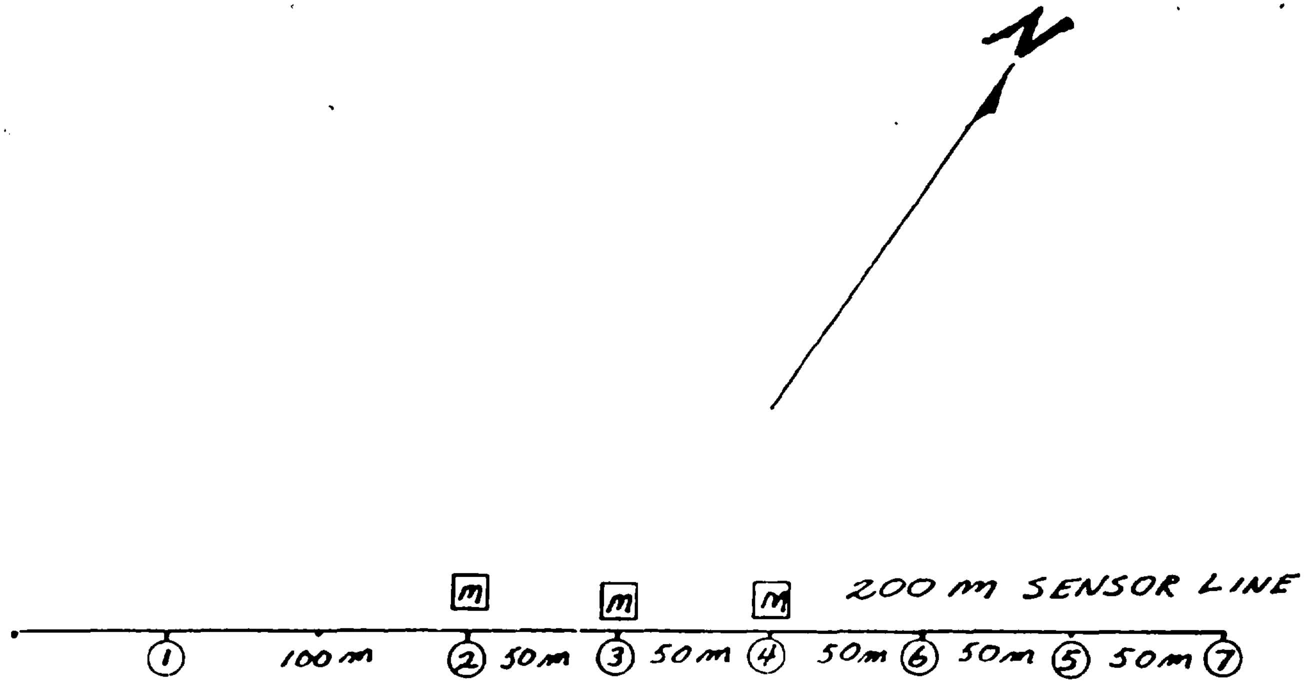
FIGURE 1



NOTES: 1. ALL DIMENSIONS IN METRES.
2. ALL BEARINGS ARE IN TRUE DEGREES.
3. STATION 8 LOCATED 1.8 KM FROM 500 m FIRING POINT ON A BEARING OF 75° FROM THE FIRING POINT

ORIGINAL LAYOUT OF CAD 2 SENSOR STATIONS

FIGURE 2



NOTES: 1. 3 DENOTES CADS 2 SENSOR STATION AND NUMBER

2. m DENOTES MINITUBE SAMPLING STATION

3. CADS STATION NUMBER 8 IS 1.8 KM FROM 500 m FIRING POINT ON A BEARING OF 75° FROM THE FIRING POINT

FINAL SITING OF SENSORS AND MINITUBE SAMPLERS

FIGURE 3

TABLE 1

RECORD OF CADS 2 DOWNWIND DETECTIONS

DATE	TIME OF DESTRUCTION (T)	NUMBER OF ROCKETS	SENSOR STATION NO.	NO. OF BARS	TIME OF DETECTION	REMARKS
27 FEB 92	1530	10				No Detections (Rocket Motors Only)
28 FEB 92	1500	5				No Detections
29 FEB 92	1205	20				No Detections
2 MAR 92	1125	20	2&3	1-GB	T+1 to T+5 mins	
2 MAR 92	1420	20				No Detections
3 MAR 92	1425	40	2	1-GB	T+1 to T+7 mins	
			3	1-GB	T+1 to T+4 mins	
			4	1-GB	T+3 mins	15 Sec Duration
			4	1-GB	T+8 mins	5 Sec Duration
			2&3	1-GB	T+7 to T+12 mins	Intermittent/Bar Readings
4 MAR 92	1556	40				No Detections
7 MAR 92	1310	40				No Detections
9 MAR 92	1114	40	2,3,4,6	1-GB	T+2 to T+4 mins	
			4	1-GB	T+4 mins	30 Sec Duration
			4	1-GB	T+5 mins	45 Sec Duration
			4	1-GB	T+6 to T+7 mins	Intermittent Readings
9 MAR 92	1424	32	4	3-GB	T+1 to T+2 mins	
			4	2-GB	T+2 to T+5 mins	
			4	3-GB	T+6 mins	15 Secs Duration
			4	3-GB	T+7 mins	15 Secs Duration
			4	3-GB	T+10 to T+11 mins	
			3	2-GB	T+1 to T+3 mins	(Note: A number of warheads were not totally destroyed/burned because they were blown clear of the pit.)
			3	1-GB	T+4 to T+5 mins	
			6	1-GB	T+1 min	

TABLE 1 (Cont'd)

RECORD OF CADS 2 DOWNWIND DETECTIONS

DATE	TIME OF DESTRUCTION (T)	NUMBER OF ROCKETS	SENSOR STATION NO.	NO. OF BARS	TIME OF DETECTION	REMARKS
10 MAR 92	1428	40	5&7	1-GB	T+1 to T+10 mins	
11 MAR 92	1126	55				No Detections
12 MAR 92	1124	44	3&4	1-GB	T+1 to T+2 mins	
12 MAR 92	1335	36				No Detections
13 MAR 92	1059	28				No Detections - Rocket Motors Only

TABLE 2

METEOROLOGICAL CONDITIONS AT TIME OF ROCKET DESTRUCTION

DATE/TIME OF DESTRUCTION	NO. ROCKETS DESTROYED	WIND SPEED (KPH)	WIND DIRECTION (DEGREES)	AIR TEMP °C	GROUND TEMP °C	HUMIDITY %	ATMOSPHERIC STABILITY (PASQUILL)	REMARKS
27 FEB 92 1530	10	27	328	15.8	26	37	D	
28 FEB 92 1500	5	34	300	17	27	20	D	
29 FEB 92 1205	20	18	290	14	26	25	B	
2 MAR 92 1125	20	17	315	16.5	26.5	40	B	
2 MAR 92 1420	20	18.5	330	20.5	26	13	B	
3 MAR 92 1425	40	38	300	19	28	30	D	
4 MAR 92 1556	40	15	315	21.8	35	28	C	
7 MAR 92 1310	40	11	330	23	32	50	B	
9 MAR 92 1114	40	11-22	285	17.8	30	46	C	
9 MAR 92 1424	32	22-33	300	22	32	40	C	Blowing sand
10 MAR 92 1428	40	18-22	280	20.5	28	35	D	
11 MAR 92 1126	55	18-22	330	16.5	34	28	C	3 rockets flew from pits

TABLE 'ont'd)

METEOROLOGICAL CONDITIONS AT TIME OF ROCKET DESTRUCTION

DATE/TIME OF DESTRUCTION	NO. ROCKETS DESTROYED	WIND SPEED (KPH)	WIND DIRECTION (DEGREES)	AIR TEMP °C	GROUND TEMP °C	HUMIDITY %	ATMOSPHERIC STABILITY (PASQUILL)	REMARKS
12 MAR 92 1124	44	11-19	300	17	32	30	C	
12 MAR 92 1335	36	15-19	335	20	40	13	C	Possibly 3 or 4 rockets undestroyed in blast
13 MAR 92 1059	28 (motors)	15	165	19	27	29	C	Uncontaminated Rocket Motors

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4. AUTHORS (Last name, first name, middle initial. If military, show rank, e.g. Doe, Maj. John E.)

Sturgeon, Capt. Wayne R.

5. DATE OF PUBLICATION (month and year of publication of document)	6a. NO. OF PAGES (total containing information. Include Annexes, Appendices, etc.)	6b. NO. OF REFS (total cited in document)
August 1992	72	0

6. DESCRIPTIVE NOTES (the category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

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Canada contributed a team of six personnel to the United Nations Special Commission 29 for the destruction of 122 millimeter chemical fill rockets at Khamisiyah, Iraq. This team was composed of two military officers and two civilian personnel from the Defence Research Establishment Suffield (DRES), Alberta, Canada, and augmented by two military personnel from Canadian Forces Europe, Lahr, Germany. The team was assigned the duties of detection, monitoring and meteorology, and deployed with them the DRES-designed Chemical Agent Detection System (CADS) II and the Minitube Air Sampling System (MASS). The CADS II and MASS were deployed downwind of the rocket destruction site for atmospheric monitoring and sample collection for retrospective analysis at DRES.

This paper details the deployment of the DRES team and equipment to Iraq during the period 12 February 1992 to 25 March 1992, the logistical and operational problems encountered, equipment performance and recommendations for improvements in a number of areas associated with the deployment.

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